J.2.2
OBO Guide Specifications

FY26
October 1, 2025

Overseas Buildings Operations
U.S. DEPARTMENT of STATE

About This Edition

The 2026 Edition of the OBO Project Standard Requirements (OPSR) is organized into the following volumes in order of precedence:

- OPSR 1 – OBO Codes*
- OPSR 2 – OBO Guide Specifications
- OPSR 3 – OBO Project Requirements
- OPSR 4 – OBO Space and Adjacencies
- OPSR 5 – OBO Deliverable Requirements
- OPSR 6 – Reserved
- OPSR 7 – OBO Standard Templates
- OPSR 8 – OBO Standard Questionnaires

*OBO Codes (U) (Full minus OBO Telecommunications Code Volume B)
*OBO Telecommunications Code Volume B (SBU)

OPSR Volumes 1-4 make up the OBO Design Standards and are under the purview of the Office of Design and Engineering (OBO/PDCS/DE). The documents contained herein represent all guidance and technical requirements for these standards.

OPSR Volumes 5-8 make up the OBO Deliverable Resources and are under the purview of the Office of Project Development and Coordination (OBO/PDCS/PDC).

Design Principles

The mission of the Bureau of Overseas Buildings Operations (OBO) is to provide the most effective facilities for conducting United States diplomacy abroad.

OBO/PDCS/DE develops the design standards and criteria for all overseas State Department facilities. OBO adopts industry codes and standards and supplements those with unique State Department requirements.

Design Tenets

Embassy and consulate buildings should present a welcoming architectural form that represents the United States and acknowledges Host Nation culture with mutual respect via architecture, design, engineering, technology, art, and culture.

The State Department expects to use and operate its buildings for many decades. This places a greater emphasis on the total cost of ownership long term. Life-cycle cost-effective energy and water efficiency measures should be incorporated to the extent operable and maintainable by local staff. Passive strategies, such as high insulation levels and thermal bridge reductions, should be prioritized over

mechanical, high-tech, or proprietary systems with greater maintenance requirements. The concept of whole-building performance must be incorporated into the design to optimize the balance of function, security, safety, energy, resiliency, operability, and maintainability.

2025-2026 Changes

The 2026 OBO Design Standards include updates to guidance and technical requirements submitted by diverse OBO subject matter experts. Some highlights include:

- **Adoption of the 2024 International Code Council Family of Codes:**
  - Moved Chapters 9 and 10 requirements from the OBO International Fire Code to the OBO International Building Code.
  - Updated Structural tables in the OBO International Building Code.
  - Added Equipment Rooms and Chemical Storage Rooms to the OBO International Swimming Pool and Spa Code.
  - Updated Harvesting Water requirements in the OBO International Zoning Code.
  - Divided the OBO Telecommunications Code into separate Unclassified (U) and Sensitive But Unclassified (SBU) volumes.
- **New OBO Guide Specification:**
  - 329300 Plants.
- **Reorganization of the OBO Project Requirements (OPR):**
  - Reformatted content so every paragraph can be cited.
  - Reordered OPR documents to match drawing documentation standards in OPSR 05 (*See Crosswalk*).
  - Consolidated OPR 4-022-01 Compound Access Control and OPR 4-201-01 Support Buildings into OPR 02 General (*See Crosswalk*).
  - Renamed OPR 2-300-01 Utility Services to OPR 08 Civil (*See Crosswalk*).
  - Renamed OPR 2-601-01 Site Design to OPR 09 Landscape (*See Crosswalk*).
  - Developed new OPR 15 Water Feature (*See Crosswalk*).
- **Elimination of the 2025 OPSR Volume 6 – OBO Reference Documents:**
  - Deleted or revised outdated drawings.
  - Incorporated revised drawings into the appropriate OPR as attachments (*See Crosswalk*).
- **Updates to the Space Requirements Program Modules (SRP-Ms):**
  - Developed new SRP-M to provide guidance on size, naming, and required components.

- Developed new SRP-Ms for the DT Suite (Diplomatic Technology).
- Created a new FLEX Mission space group that includes all standard SRP-Ms.

Please reference the CCR Change Log and FY26 Crosswalks (OPR and Drawings) for detailed information concerning incorporated changes. For changes related to SRP-Ms and adjacency diagrams, reference the *Summary of Changes* tables in OPSR 4 – OBO Space and Adjacencies.

Contact designstandards@state.gov for general questions or comments about these standards. If you are under contract on a State Department project, you must go through your Contracting Officer's Representative for any contract-related questions.

LIMITED CONTENT - REPRODUCTION AND DISTRIBUTION IS AUTHORIZED BUT RESTRICTED
The content included in this version of OBO Standard Project Requirements may be limited based on project scope and sensitivity of the security-related information. Such information is marked *Sensitive but Unclassified* (SBU) or *Controlled Unclassified Information* (CUI) and will not be included in publicly released versions of these documents. The SBU (and higher) information will be available through the Contracting Officer's Representative after the requestor's need and credentials are authenticated. Unclassified content herein may become SBU/CUI once linked to a specific project, site, or building and must be handled accordingly. **Click here for more information and SBU/CUI handling instructions and cover page.**

CHANGE LOG

2026 OBO Project Standard Requirements (OPSR) Content Changes

Note: Changes listed here are not exhaustive and are provided for user convenience only. Contractors are responsible for compliance with all technical requirements.

Document/ Section	Chapter	Change
General		
All documents	N/A	Revised formatting of published documents to enhance searchability.
OPSR 1 - OBO Codes		
IBC	Table of Contents	Added chapter 35.
IBC	Ch 1 - Scope and Administration	Added section 105.2 and renumbered subsequent sections.
IBC	Ch 1 - Scope and Administration	Revised section 104 to adopt the 2024 ICC code editions.
IBC	Ch 1 - Scope and Administration	Revised section 105.1.1 regarding requiring permits.
IBC	Ch 1 - Scope and Administration	Revised section 107.
IBC	Ch 4 - Special Detailed Requirements based on Use and Occupancy	Deleted section 428.3.5 from Representational Housing Section.
IBC	Ch 4 - Special Detailed Requirements based on Use and Occupancy	Renumbered sections to align with IBC.
IBC	Ch 5 - General Building Heights and Areas	Deleted section 505.
IBC	Ch 7 - Fire and Smoke Protection Features	Added requirement to 703.7 to state rating.
IBC	Ch 9 - Fire Protection and Life Safety Systems	Relocated fire alarm requirements from specifications to code.
IBC	Ch 9 - Fire Protection and Life Safety Systems	Relocated IFC Chapter 9 requirements to IBC Chapter 9.
IBC	Ch 11 - Accessibility	Revised and added sections to Ch. 11.

Document/ Section	Chapter	Change
IBC	Ch 12 - Interior Environment	Revised formatting of section 1208 to match code style guide.
IBC	Ch 12 - Interior Environment	Revised section 1206.5.1.
IBC	Ch 15 - Roof Assemblies and Rooftop Structures	Revised section 1506.4.
IBC	Ch 16 - Structural Design	Revised section 1624.
IBC	Ch 16 - Structural Design	Revised section 1624.2.2.
IBC	Ch 24 - Glass and Glazing	Revised paragraph 2405.6.
IBC	Ch 24 - Glass and Glazing	Revised section 1.2.D.
IBC	Ch 29 - Plumbing	Revised section 2902.1.2.
IBC	Ch 29 - Plumbing	Revised sections 2902.3.3 and 2902.3.3.1.
IBC	Ch 34 - Physical and Technical Security Requirements	Revised requirements for manhole cover locks.
IBC	Ch 34 - Physical and Technical Security Requirements	Added reference to OTC requirements to 3420.5.3.3.
IBC	Ch 34 - Physical and Technical Security Requirements	Deleted language in 3404.9.8.2 regarding specific types of locks.
IBC	Ch 34 - Physical and Technical Security Requirements	Deleted section 3403.11.1 and renumbered remaining sections.
IBC	Ch 34 - Physical and Technical Security Requirements	Renumbered section 3404.8.2.
IBC	Ch 34 - Physical and Technical Security Requirements	Revised and renamed 3404.9.2 regarding egress route and elevator vestibules.
IBC	Ch 34 - Physical and Technical Security Requirements	Revised section 3404.11.3.
IBC	Ch 34 - Physical and Technical Security Requirements	Revised section 3404.5.1.1.
IBC	Ch 34 - Physical and Technical Security Requirements	Revised section 3404.9.2:
IBC	Ch 34 - Physical and Technical Security Requirements	Revised section 3420.4.1.3.
IBC	Ch 34 - Physical and Technical Security Requirements	Revised sections 3404.9.6.3, 3404.9.2.1 & 3404.9.2.2
IBC	Appendix N Replicable Buildings	Deleted the year reference.
IBC	Appendix W	Replaced references to Appendix R with Appendix W.

Document/ Section	Chapter	Change
IEBC	Ch 10 - Change in Occupancy	Revised section 1006 to correct reference to section 304.3.1.
IFC	Ch 5 - Fire Service Features	Revised to address possible locations for fire command center.
IFC	Ch 9 - Fire Protection and Life Safety Systems	Clarified section 907.2.2.2 regarding smoke detection.
IFC	Ch 9 - Fire Protection and Life Safety Systems	Revised section 906.1.2.1.3 item 1.
IFC	Ch 10 - Means of Egress	Added reference to OBO-ICS IBC and clarified where it differed.
IMC	Ch 1 - Scope and Administration	Clarified that HHW is prohibited in PCC.
IMC	Ch 3 - General Requirements	Revised language to address corrosion concerns.
IMC	Ch 3 - General Requirements	Revised section 312.2.
IMC	Ch 3 - General Requirements	Revised section 313.6.1.
IMC	Ch 4 - Ventilation	Clarified section 403.3 regarding circulation spaces.
IMC	Ch 4 - Ventilation	Revised chapter 4 to coordinate with OBO-ICS IBC chapter 34.
IMC	Ch 5 - Exhaust Systems	Revised section 504.3.
IMC	Ch 5 - Exhaust Systems	Revised to prescribe generator exhaust termination locations.
IMC	Ch 11 - Refrigeration	Clarified PCC chillers do not count as one of the offline chillers.
IMC	Ch 12 - Hydronic Piping	Revised materials table. See footnotes.
IMC	Ch 13 - Fuel Oil Piping and Storage	Revised to prevent overflow of fuel in generator room.
IPC	Ch 6 - Water Supply and Distribution	Added meter requirements for irrigation water to IZC.
IRC	Ch 3 - Building Planning	Deleted reference to Design Criteria document.
IRC	Ch 3 - Building Planning	Revised section 310 Residential Group R for consistency.
IRC	Ch 6 - Wall Construction	Clarified section R609.1.1 to prohibit PVC and PVC-clad windows and door frames.

Document/ Section	Chapter	Change
IRC	Table of Contents	Rejected new 2024 IRC Appendices NC, NF, NG, NH, and NJ.
ISPSC	Ch 4 - Public Swimming Pools	Relocated text from section 320 (formerly 319) and incorporated into section 325.
IZC	Ch 6 - Commercial and Commercial/Residential Zones	Added section 604.3.4.
IZC	Ch 6 - Commercial and Commercial/Residential Zones	Revised section 604.10.
IZC	Ch 8 - General Provisions	Added exemption in 812.5.4.3
IZC	Ch 8 - General Provisions	Added fall protection requirement in 812.2.16.2.
IZC	Ch 8 - General Provisions	Added list in 818.2 regarding corrosion resistance.
IZC	Ch 8 - General Provisions	Clarified language 813.3.4.
IZC	Ch 8 - General Provisions	Clarified section 801.4.2.
IZC	Ch 8 - General Provisions	Clarified section 813.3.2.2.
IZC	Ch 8 - General Provisions	Clarified sections 802, 803, and 804 are not adopted.
IZC	Ch 8 - General Provisions	Deleted hydraulic equipment from 813.8.1.
IZC	Ch 8 - General Provisions	Deleted section 801.3.3.
IZC	Ch 8 - General Provisions	Renumbered paragraphs 813.3.3.1 thru 813.3.5.4 with new numbers 813.3.4 thru 813.3.12.4.
IZC	Ch 8 - General Provisions	Revised paragraphs and titles in subsections from 813 to 816.
IZC	Ch 8 - General Provisions	Revised section 811.3.1.1.
IZC	Ch 8 - General Provisions	Revised section 812 for clarity.
IZC	Ch 8 - General Provisions	Revised sections 813.3.12.3 through 816.13.
IZC	Ch 8 - General Provisions	Revised site slope requirements.
NEC	Ch 2 - Wiring and Protection	Revised cable sizes for consistency.
OTC	Ch 1 - Scope and Administration	Added section 101.1.1.
OTC	Ch 1 - Scope and Administration	Deleted language from 101.3.1.
OTC	Ch 2 - Definitions	Added definition "Work Area Outlet (WAO)".

Document/ Section	Chapter	Change
OTC	Ch 2 - Definitions	Revise definition of Distribution Device (DD).
OTC	Ch 3 - General Requirements	Deleted section 306.4
OTC	Ch 3 - General Requirements	Revised section 303.2.1.1.
OTC	Ch 3 - General Requirements	Revised section 304.1.2.
OTC	Ch 3 - General Requirements	Revised section 305.1.6.
OTC	Ch 3 - General Requirements	Revised section 308.1.1.
OTC	Ch 3 - General Requirements	Revised section 308.4.
OTC	Ch 4 - Service Entrance and Site Distribution	Deleted OTC section 404.1 #2.
OTC	Ch 4 - Service Entrance and Site Distribution	Revised section 402.1.
OTC	Ch 4 - Service Entrance and Site Distribution	Revised section 405.1.
OTC	Ch 4 - Service Entrance and Site Distribution	Revised section 405.5.6.
OTC	Ch 5 - Telecommunications Equipment Spaces	Revised section 501.2.
OTC	Ch 5 - Telecommunications Equipment Spaces	Revised section 502.3.
OTC	Ch 5 - Telecommunications Equipment Spaces	Revised section 502.5.
OTC	Ch 5 - Telecommunications Equipment Spaces	Revised section 504.1.1.
OTC	Ch 6 - General Telecommunications Cabling for Buildings	Revised chapter 6.
OTC	Ch 6 - General Telecommunications Cabling for Buildings	Revised section 605.2.
OTC	Ch 11 - Telecommunications for Residential Buildings	Revised chapter 11.
OTC	Ch 15 - General Telecommunications for Office Buildings	Revised chapter 15.
OTC	Ch 15 - General Telecommunications for Office Buildings	Revised section 1112.1.
OTC	Ch 16 - Telecommunications Equipment Spaces in Office Buildings	Revised chapter 16.
OTC	Ch 17 - Telecommunications Cabling for Office Buildings	Revised chapter 17.
OPSR 2 - Guide Specifications		
Division 06	061719 - Cross-Laminated Timber Panels	Added sections 1.4.D, 1.7, and 3.6.
Division 06	061800 - Glued-Laminated Construction	Added section 1.4.F, 1.8, and 3.5.
Division 08	087135 - Non-Security Door Hardware	Revised section 1.2.D - Keying Schedule.
Division 08	087135 - Non-Security Door Hardware	Revised sections 2.6.A, 2.6.B.1 and 2.6.C.4.

Document/ Section	Chapter	Change
Division 08	087155 - Security Door Hardware	Revised specification 087155-B Defense Attache suite hardware.
Division 08	088855 - Security Glazing	Revised specification.
Division 10	104415 - Fire-Protection Specialties	Revised specification.
Division 11	114000 - Food Service Equipment	Revised section 3.9.
Division 11	115700 - Shop Equipment	Revised Basis of Design models.
Division 11	115700 - Shop Equipment	Revised section 2.10.F
Division 11	117000 - Medical Equipment	Revised specification section 2.14 basis of design for surgical light.
Division 11	118126 - Window Washing and Fall Protection Accessories	Renamed specification.
Division 14	142105 - Electric Tractions Elevators	Revised language regarding combustible suspension.
Division 21	211305 - Fire Sprinkler Systems	Revised language in specification.
Division 21	211305 - Fire Sprinkler Systems	Revised reference standard in section 2.4.H.
Division 21	211305 - Fire Sprinkler Systems	Revised referenced codes.
Division 22	223230 - Potable Water Treatment	Revised language in specification.
Division 23	230905 - Instrumentation and Controls for HVAC	Revised language in section 1.2.B.
Division 23	230905 - Instrumentation and Controls for HVAC	Revised section 3.2.
Division 23	230905 - Instrumentation and Controls for HVAC	Revised specification section 1.2.F.
Division 23	230905 - Instrumentation and Controls for HVAC	Revised table 3.13.4 footnote to coordinate terminology.
Division 23	234105 - Air Filtration	Modified number of FCU filters to be provided.
Division 23	236427 - Air-Cooled, Rotary-Screw Water Chillers	Revised reference standards in 2.11.C.
Division 23	236427 - Air-Cooled, Rotary-Screw Water Chillers	Revised specification to require chilled water treatment startup.
Division 23	237315 - Central-Station Air Handling Units	Added designer notes to paragraph 2.2.
Division 23	237315 - Central-Station Air Handling Units	Added designer notes to specification.
Division 23	237315 - Central-Station Air Handling Units	Deleted requirement for davits.
Division 23	237315 - Central-Station Air Handling Units	Revised section 2.2.B.

Document/ Section	Chapter	Change
Division 23	237315 - Central-Station Air Handling Units	Revised specification regarding submittals.
Division 23	237315 - Central-Station Air Handling Units	Revised specification section 1.4.
Division 26	260525 - Grounding and Bonding for Electrical Systems	Clarified section 2.1.G regarding bonding requirements.
Division 26	260815 - Field Testing and Inspection Of Electrical Systems	Added sub-paragraph 3.1.C.
Division 26	262325 - Power Sequence Of Operation	Added paragraph 1.7.
Division 26	262325 - Power Sequence Of Operation	Added sub-paragraph 1.6.B.
Division 26	262725 - Wiring Devices	Revised requirements section 2.2.B.1.
Division 26	263214 - Engine Generators	Deleted section 1.2.A.2 to defer to generator manufacturer.
Division 26	263214 - Engine Generators	Revised reference standards in sections 1.2.A and 2.8.B.
Division 26	263214 - Engine Generators	Revised section 2.8.B ASTM references.
Division 26	263552 - Low-Voltage Automatic Voltage Regulators	Added designers note to clarify use.
Division 27	270508 - Common Work Results for Telecommunications	Revised specification.
Division 27	270526 - Grounding and Bonding for Communications Systems	Revised specification.
Division 27	270528 - Surface-Mounted Raceways for Communication Systems	Revised section 2.2.C.
Division 27	270553 - Identification for Communications Systems	Revised specification.
Division 27	270645 - Schedules for Audiovisual Systems	Revised specification.
Division 27	271113 - Communications Entrance Protection	Revised specification.
Division 27	271116 - Communications Cabinets and Frames	Revised specification.
Division 27	271119 - Communications Termination Blocks and Patch Panels	Revised specification.
Division 27	271123 - Communications Cable Management and Ladder Rack	Revised specification.
Division 27	271305 - Communications Backbone Cabling	Revised specification.
Division 27	271505 - Communications Horizontal Cabling	Revised language in section 2.2-A-2.
Division 27	271505 - Communications Horizontal Cabling	Revised specification.
Division 27	271543 - Communications Faceplates and Connectors	Revised specification.
Division 27	272129 - Data Communication Switches and Power Supplies	Revised specification.
Division 27	274100 - Audiovisual Systems General Requirements	Revised specification.

Document/ Section	Chapter	Change
Division 27	274114 - Architecturally-Integrated Audiovisual Elements	Revised specification.
Division 27	274117 - Projection Screens and Projector Lifts	Revised specification.
Division 27	275105 - Audio Systems for Consular Services	Revised specification.
Division 27	275118 - Sound Masking System	Revised language.
Division 27	275118 - Sound Masking System	Revised specification.
Division 27	275405 - Consular Queue Management System Infrastructure and Displays	Revised specification.
Division 28	284626 - Addressable Fire Alarm Systems	Revised referenced codes.
Division 32	323305 - Site Furnishings	Added new specification.
Division 33	337105 - Underground Ducts and Raceways	Revised section 2.5.
OPSR 3 - OBO Project Requirements		
All OPRs	N/A	Renumbered and renamed OPRs in a logical manner.
N/A	OPR 02 General	Added new specification.
N/A	OPR 02 General	Revised section 1208.6.6 regarding maximum guard both height.
N/A	OPR 02 General	Revised section 2-4.5.1.
N/A	OPR 02 General	Revised to provide 3m clearance.
N/A	OPR 04 Physical Security	Incorporated updated Red Book.
N/A	OPR 04 Physical Security	Incorporated updated Red Book.
N/A	OPR 09 Landscape (Formerly Site Design)	Added new specification.
N/A	OPR 09 Landscape (Formerly Site Design)	Added new specification.
N/A	OPR 09 Landscape (Formerly Site Design)	Added new specification.
N/A	OPR 09 Landscape (Formerly Site Design)	Revised OPR regarding pool deck material.
N/A	OPR 09 Landscape (Formerly Site Design)	Revised OPR.
N/A	OPR 09 Landscape (Formerly Site Design)	Revised section 2-7.2.9.1.
N/A	OPR 10 Architecture	Renamed section 2-1.2.3.

Document/ Section	Chapter	Change
N/A	OPR 10 Architecture	Revised language to include bumper guards in service corridors.
N/A	OPR 10 Architecture	Revised OPR regarding exterior finish materials.
N/A	OPR 10 Architecture	Revised OPR regarding finish flooring installation.
N/A	OPR 10 Architecture	Revised requirements regarding glass railings.
N/A	OPR 10 Architecture	Revised section 2-1.1.1-5 regarding fire pump room access.
N/A	OPR 10 Architecture	Revised section 2-1.2.3.3 regarding roof hatches.
N/A	OPR 10 Architecture	Revised section 3.1.1.1 regarding vision panels.
N/A	OPR 15 Water Feature	Added new OPR.
N/A	OPR 18 Mechanical	Revised OPR regarding equipment replacement.
N/A	OPR 18 Mechanical	Revised section 2.1.
N/A	OPR 18 Mechanical	Revised section 2-1.3 regarding filter trays.
N/A	OPR 18 Mechanical	Revised section 2-1.4.3 regarding area drains.
N/A	OPR 20 Fire Protection	Added sections 2-2 and 2-3.
N/A	OPR 26 Telecommunications and Audio Visual	Revised language in section 3.3.1.1 C.
N/A	OPR 26 Telecommunications and Audio Visual	Revised OPR.
N/A	OPR 31 Specifications Criteria	Added to Attachment D Standard Extra Material (Spare Parts).
N/A	OPR 31 Specifications Criteria	Aligned content with OBO Deliverable Requirements.

01 Organization of Specification Divisions

Microsoft Word versions of the OBO Guide Specifications can be obtained for use on specific projects by contacting the assigned COR. See OPR 31 Specifications Criteria for additional technical requirements.

Division 01 – General Conditions

OBO Division 01 standard specifications sections are produced by the Office of Construction Management (OBO/CFSM/CM) and provided on a project-specific basis. Contract A/E teams can obtain them through their designated COR.

Division 02 – Existing Conditions

No OBO Guide Specification sections in this Division

Division 03 – Concrete

- 033000 Cast-in-Place Concrete 2023-10-01

Division 04 – Masonry

No OBO Guide Specification sections in this Division

Division 05 – Metals

- 055005 Metal Fabrications 2024-10-01
- 057005 Decorative Metal 2023-10-01
- 057305 Decorative Metal Railings 2025-10-01

Division 06 – Wood, Plastics & Composites

- 061719 Cross-Laminated Timber Panels 2025-10-01
- 061800 Glue-Laminated Construction 2025-10-01
- 062025 Interior Finish Carpentry 2023-10-01
- 064023 Interior Architectural Woodwork 2023-10-01

Division 07 – Thermal & Moisture Protection

- 074115 Standing-Seam Metal Roof Panels 2023-10-01
- 074215 Insulated Metal Wall Panels 2023-10-01

- 075558 Fluid-Applied Protected Membrane Roofing 2023-10-01
- 076205 Sheet Metal Flashing and Trim 2023-10-01
- 077234 Forced-Entry/Ballistic-Resistant (BR) Roof Hatches 2023-10-01

Division 08 – Openings

- 080001 Blast Requirements 2023-10-01
- 081115 Hollow Metal Doors and Frames 2023-10-01
- 081415 Flush Wood Doors 2023-10-01
- 083115 Access Doors and Frames 2023-10-01
- 083322 Overhead Forced-Entry (FE) Coiling Doors 2023-10-01
- 083454 FE / BR Door Assemblies 2025-10-01
- 083459 Vault Doors and Accessories 2025-10-01
- 084414 Structurally-Framed Security Curtain Wall System 2024-10-01
- 085651 Aluminum Security Windows 2024-10-01
- 085652 Aluminum Security Teller Windows 2025-10-01
- 087135 Non-Security Door Hardware 2024-10-01
- 087155 Security Door Hardware 2025-10-01
- 088855 Security Glazing 2025-10-01
- 089117 Security Louvers 2023-10-01

Division 09 – Finishes

- 092400 Cement Plastering 2023-10-01
- 092900 Gypsum Board 2023-10-01
- 093013 Ceramic Tiling 2023-10-01
- 095113 Acoustical Panel Ceiling 2023-10-01
- 095423 Linear Metal Ceiling 2023-10-01
- 096340 Stone Flooring 2023-10-01
- 096400 Wood Flooring 2023-10-01
- 096513 Resilient Base and Accessories 2023-10-01
- 096536 Static-Control Resilient Floor Coverings 2023-10-01
- 096623 Resinous Matrix Terrazzo Flooring 2023-10-01
- 096800 Carpeting 2023-10-01
- 097200 Wall Coverings 2023-10-01
- 097513 Stone Wall Facing 2023-10-01

- 098433 Sound-Absorbing Wall Units 2023-10-01
- 099601 High-Performance Coatings for General Usage 2024-10-01
- 099602 High-Performance FE/BR Coatings 2024-10-01

Division 10 – Specialties

- 101100 Visual Display Units 2023-10-01
- 101415 Post and Panel Pylon Exterior Signage 2023-10-01
- 101425 Interior Panel Signage 2023-10-01
- 102113 Toilet Compartments 2023-10-01
- 104415 Fire Protection Specialties 2025-10-01
- 105110 Cell Phone Locker 2024-10-01
- 105613 Metal Storage Shelves 2023-10-01
- 105640 Safety Storage Cabinets 2023-10-01

Division 11 – Equipment

- 111126 Vehicle Washing Equipment 2023-10-01
- 111305 Load Dock Equipment 2023-10-01
- 112173 Commercial Laundry Equipment 2023-10-01
- 113013 Residential Appliances 2024-10-01
- 114000 Foodservice Equipment 2025-10-01
- 115355 Class I Biological Safety Cabinets 2023-10-01
- 115700 Shop Equipment 2025-10-01
- 117000 Medical Equipment 2025-10-01
- 118126 Façade Maintenance and Fall Protection Accessories 2025-10-01

Division 12 – Furnishings

- 122413 Roller Window Shades 2023-10-01
- 124816 Entrance Floor Grilles 2023-10-01
- 125005 GFE Furniture Installation 10-16-2024
- 125705 Work Benches 2025-10-01

Division 13 – Special Construction

- 133435 Mail Screening Facilities 2023-10-01

Division 14 – Conveying Equipment

- 142105 Electric Traction Elevators 2025-10-01
- 144500 Vehicle Lifts 2023-10-01

Divisions 15 – 20

No OBO Guide Specification sections in these Divisions

Division 21 – Fire Suppression

- 211305 Fire Sprinkler Systems 2025-10-01
- 213115 Fire Pump Assemblies 2025-10-01

Division 22 – Plumbing

- 223230 Potable Water Treatment 2025-10-01
- 224105 Residential Plumbing Fixtures 2023-10-01
- 224215 Commercial Plumbing Fixtures 2025-10-01
- 224500 Emergency Plumbing Fixtures 2024-10-01

Division 23 – Heating Ventilation & Air Conditioning

- 230593 Testing, Adjusting, and Balancing for HVAC 2024-10-01
- 230719 HVAC Piping Insulation 2024-10-01
- 230805 Commissioning of HVAC 2023-10-01
- 230905 Instrumentation and Controls for HVAC 2025-10-01
- 234105 Air Filtration 2025-10-01
- 236422 Heat Recovery Chillers & Simult. Heat-Cool Chillers 2024-10-01
- 236427 Air-Cooled Rotary-Screw Water Chillers 2025-10-01
- 236434 Modular Air-Cooled Water Chillers 2025-10-01
- 237315 Central-Station Air-Handling Units 2025-10-01

Divisions 24 – 25

No OBO Guide Specification sections in these Divisions

Division 26 – Electrical

- 260508 Common Work Results for Electrical, Communication & Electronic Safety 2023-10-01

- 260518 Low-Voltage Electrical Power Conductors and Cables 2025-10-01
- 260525 Grounding and Bonding for Electrical Systems 2025-10-01
- 260573 Overcurrent Protective Device Coordination Study 2023-10-01
- 260815 Field Testing and Inspection of Electrical Systems 2025-10-01
- 260915 Electrical Power Monitoring 2023-10-01
- 260924 Lighting Control Devices 2023-10-01
- 260934 Centralized Dimming Controls 2023-10-01
- 261214 Medium-Voltage Transformers 2023-10-01
- 262214 Low-Voltage Transformers 2023-10-01
- 262300 Low-Voltage Switchgear 2023-10-01
- 262313 Paralleling Switchgear 2023-10-01
- 262315 Double-Ended Switchgear 2023-10-01
- 262325 Power Sequence of Operation 2025-10-01
- 262412 Switchboards 2023-10-01
- 262417 Panelboards 2025-10-01
- 262500 Enclosed Bus Assemblies 2023-10-01
- 262725 Wiring Devices 2025-10-01
- 263105 Solar Photovoltaic Systems 2023-10-01
- 263214 Engine Generators 2025-10-01
- 263237 Resistive Load Banks 2023-10-01
- 263313.11 Residential Energy Storage Systems 2024-10-01
- 263313.12 Energy Storage Systems (50 kWh UP TO 600 kWh) 2024-10-01
- 263313.13 Energy Storage Systems (OVER 600 kWh) 2024-10-01
- 263354 UPS for Telecommunications 2025-10-01
- 263535 Power Factor Correction Equipment 2023-10-01
- 263552 Low-Voltage Automatic Voltage Regulators 2023-10-01
- 263554 Medium-Voltage Automatic Voltage Regulators 2023-10-01
- 263600 Transfer Switches 2025-10-01
- 264115 Lightning Protection 2023-10-01
- 264315 Surge Protective Devices 2023-10-01
- 265105 Interior Lighting 2023-10-01
- 265554 Undercarriage Vehicle Inspection Lighting 2023-10-01
- 265600 Exterior Lighting 2023-10-01

Division 27 – Communications (Comms)

- 270508 Common Work Results for Telecommunications 2025-10-01
- 270526 Grounding and Bonding for Comms Systems 2023-10-01
- 270528 Surface-Mounted Raceways for Comms Systems 2023-10-01
- 270553 Identification for Communications Systems 2025-10-01
- 270645 Schedules for Audiovisual Systems 2025-10-01
- 271113 Communications Entrance Protection 2025-10-01
- 271116 Communications Cabinets and Frames 2025-10-01
- 271119 Comms Termination Blocks and Patch Panels 2025-10-01
- 271123 Comms Cable Management and Ladder Racks 2024-10-01
- 271305 Communications Backbone Cabling 2025-10-01
- 271505 Communications Horizontal Cabling 2025-10-01
- 271543 Communications Faceplates and Connectors 2025-10-01
- 272129 Data Communications Switches and Power Supplies 2025-10-01
- 274100 Audiovisual Systems General Requirements 2025-10-01
- 274114 Architecturally-Integrated Audiovisual Elements 2025-10-01
- 274117 Projection Screens for Consular Services 2025-10-01
- 275105 Audio Systems for Consular Services 2025-10-01
- 275118 Sound Masking System 2025-10-01
- 275124 General-Use Teller Window Intercoms Systems 2025-10-01
- 275405 Consular Queue Mgmt Sys Infrastructure & Displays 2025-10-01

Division 28 – Electronic Safety & Security

- 280508 Common Work Results for Technical Security (TSS) 2025-10-01
- 281005 Technical Security Access Systems 2023-10-01
- 281805 Technical Security Access Equipment 2025-10-01
- 282305 Security Video System 2025-10-01
- 283105 Technical Security Intrusion Detection Systems 2024-10-01
- 283325 TSS Intercommunications Systems 2025-10-01
- 283337 Technical Security Duress Systems 2023-10-01
- 284626 Addressable Fire Alarm Systems 2025-10-01
- 284705 Mass Notification Systems 2025-10-01
- 284800 Areas of Refuge Emergency Comms Systems 2023-10-01
- 285115 Security Management System Enterprise (SMSe) 2023-10-01

Divisions 29 – 30

No OBO Guide Specification sections in these Divisions

Division 31 – Earthwork

- 311005 Site Clearing 2023-10-01
- 311305 Temporary Trees and Plant Protection 2025-10-01
- 312000 Earth Moving 2025-10-01
- 312319 Dewatering 2023-10-01
- 312507 Temporary Erosion and Sedimentation Control 2023-10-01
- 313117 Termite Control 2023-10-01
- 315000 Excavation Support and Protection 2023-10-01
- 316213 Concrete Piles 2023-10-01
- 316216 Steel Piles 2023-10-01
- 316219 Timber Piles 2023-10-01
- 316223 Composite Piles 2023-10-01
- 316316 Auger Cast Grout Piles 2023-10-01
- 316329 Drilled Concrete Piers and Shafts 2023-10-01

Division 32 – Exterior Improvements

- 323118 Decorative Metal Fences and Gates 2025-10-01
- 323305 Site Furnishings 2023-10-01
- 324003 Anti-Climb Gate Systems 2024-10-01
- 324004 Anti-Ram Gate Systems 2025-10-01
- 324007 Active Roadway Barrier Systems 2025-10-01
- 324008 Rising Bollard Barricade Systems 2025-10-01
- 324009 Crash-Rated Drop Arm Systems 2025-10-01
- 329300 Plants[New] 2025-10-01

Division 33 – Utilities

- 331117 Water Supply Wells 2023-10-01
- 331414 Fire Service Mains and Appurtenances 2025-10-01
- 331416 Site Water Distribution Piping 2023-10-01
- 333700 Wastewater Treatment Plant 2023-10-01
- 335005 Underground Fuel Storage Tanks and Distribution 2024-10-01

- 335217 Motor Vehicle Fuel Dispensing 2023-10-01
- 337105 Underground Ducts and Raceways 2024-10-01

Divisions 34 – 50

No OBO Guide Specification sections in Divisions 34 or beyond

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, concrete mixture performance, qualification testing, production testing, placement procedures, and finishes, for the following:

1. Footings and Foundations.
2. Foundation walls.
3. Slabs-on-grade.
4. Suspended slabs.
5. Concrete toppings.
6. Building frame members.
7. Building walls.
8. Equipment pads and bases.
9. Topping slabs.
10. Site perimeter walls, concrete filled bollards, and site structures.

B. Related Sections:

1. Division 31 Section on earth moving for drainage fill under slabs-on-grade.
2. Division 31 Section “Termite Control” for termiticides applied to slabs-on-grade, basement slabs, and foundations.
3. **[Division 31 Section on drilled concrete piers and shafts for drilled pier foundations.]**
4. Division 32 Section on concrete paving for concrete pavement and walks.
5. **[Division 32 Section on decorative cement concrete pavement.]**

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: Blended hydraulic cement, fly ash, metakaolin and other pozzolans, slag cement, and silica fume; subject to compliance with requirements.

B. Concrete Class: The performance requirements for structural concrete. Unless otherwise specified by Project Director/COR, the specification requirements shall be defined by the Engineer of Record. All concrete to be placed in the project shall have a Concrete Class designation. Exposure conditions outlined in ACI 318 shall be included in the Concrete Class definition.

C. Independent Quality Assurance Inspector: An independent third-party quality assurance firm retained by Contractor to serve inspection, oversight, and specification compliance tasks for the project including for concrete materials, concrete mixtures, reinforcing steel, and others as applicable.

D. Mass Concrete: A concrete element shall be treated as mass concrete when any of the following is true:

1. Concrete element is indicated to be mass concrete on the project drawings.
2. Minimum dimension of concrete element exceeds 1200 mm.
3. Concrete element is constructed in two or more smaller adjoining concrete placements to avoid treatment as mass concrete, unless a minimum period of 3 days is provided between smaller adjoining placements.

E. Specified Concrete Performance: Specified limiting value of a test result that indicates acceptable material quality or workmanship. Quality acceptance limits are based on design criteria that is provided as not-to-exceed values where values lower than specified indicate acceptable material (i.e., drying shrinkage); or as lower-bound limits where larger values indicate acceptable material (i.e., such as compressive strength).

F. Service Life: Government's stated expectation for number of years that structure will function without needing major concrete rehabilitation. Service life is defined as number of years before major restoration is necessary given minimal maintenance to structure during its life in accordance with OBO Design Code. Major restoration is defined as extensive areas that require extensive repairs using jack hammer or other destructive means to prepare concrete for rehabilitation. Unless otherwise specified, Service life is further defined as summation of corrosion initiation period (Ti) and corrosion propagation period (Tp) for given concrete system.

G. Supplemental Corrosion Protection: Includes (but not limited to) fusion-bonded epoxy-coated reinforcing steel, galvanized reinforcing steel, stainless reinforcing steel, corrosion inhibitors, barrier coatings to concrete surface, and cathodic protection.

H. Supplementary Cementitious Materials (SCM): Cementitious materials other than portland cement or blended cements that include fly ash, and granulated blast-furnace slag, when used in such proportions to replace portland cement that result in considerable improvement to durability and in some cases a reduction in cost.

I. Temperature Difference: Difference in temperature, at any point in time, between hottest portion of concrete placement and any point 50 to 75 mm into concrete on surface of concrete placement.

J. Test Section: Slab or wall separate from main structure and constructed prior to main construction as all-inclusive demonstration of methods and materials. Adequacy of the Test Section must be approved by Contracting Officer prior to construction of the project.

K. Thermal Control Period: Period of time when temperatures and temperature differences within concrete placement are required to be controlled. This period starts at completion of concrete placement and ends when hottest portion of placement cools such that removal of insulation will not cause excessive temperature difference in concrete placement.

L. Thermal Controls: Measures used to control temperatures and temperature differences within mass concrete placement.

M. Thermal Control Plan: Submittal from the Contractor to the OBO Project Director/COR that documents how temperatures and temperature differences will be controlled in mass concrete placement. Thermal control plan shall conform to minimum requirements of this Section.

N. Tolerance: Margin of deviation for each of specified concrete performance. Concrete material or workmanship performance found to be outside of Tolerance will result in Non-Compliance Report.

O. Water/Cementitious Materials Ratio (w/cm): Ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Project site in accordance with requirements of Division 01 and the following:

1. Conduct conference at least 35 days prior to submitting concrete design mixtures to review detailed requirements for preparing concrete design mixtures and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Coordinate timing of conference with the Project Director/COR to facilitate their attendance.
2. Required Attendees: Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

    a. Contractor's superintendent.
    b. Agency responsible for design concrete mixtures.
    c. Agency responsible for independent testing.
    d. Ready-mix concrete producer.
    e. Primary admixture manufacturer.
    f. Concrete subcontractor.
    g. Formwork subcontractor.
    h. Steel reinforcing installer subcontractor.
    i. Quality Control Manager.
    j. Project Director/COR.
    k. Engineer of Record.
    l. Architect of Record.
    m. Bridging Engineer and Bridging Architect.

3. Agenda:

    a. Special inspection and testing and inspecting agency procedures for field quality control.
    b. Concrete finishes and finishing.
    c. Cold- and hot-weather concreting procedures.
    d. Curing procedures.
    e. Construction contraction and isolation joints, and joint-filler strips.
    f. Semi-rigid joint fillers.

g. Forms and form removal limitations.
h. Shoring and reshoring procedures.
i. Vapor-retarder installation.
j. Anchor rod and anchorage device installation tolerances.
k. Steel reinforcement installation.
l. Floor and slab flatness and levelness measurement.
m. Concrete repair procedures.
n. Concrete protection.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.

a. Include statement indicating costs for each product having recycled content.

2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as replacement for portland cement or other portland cement replacements, and for equivalent concrete mixtures that do not contain portland cement replacements.

C. Design Mixtures: Submit for each class of concrete field or laboratory test records used to document that proposed mixture will achieve the required average compressive strength and other specified requirements in Part 2 Articles on REPAIR MATERIALS, CONCRETE MIXTURES GENERAL, CONCRETE MIXTURES BUILDING ELEMENTS, CONCRETE MIXTURES CLASSES, and CONCRETE MIXING. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Use form in Attachment A to this Section.

D. Shop Drawings:

1. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
2. Formwork Shop Drawings: Prepared by or under supervision of qualified professional engineer detailing fabrication, assembly, and support of formwork. Show location and detail construction joints for concrete work. Show form construction including jointing, special form joints and reveals, location and pattern of form ties placement, and other items that affect exposed concrete visually.

a. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

b. Review by the Project Director/COR is for general applications and features only. Formwork design and shoring sequence for structural stability and efficiency is Contractor's responsibility.

3. Construction Joint Layout Drawings: Indicate proposed construction joints required to construct structure.

a. Location of construction joints is subject to approval of the Project Director/COR.

E. Samples: For waterstops.

F. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

G. Concrete Placement Plan: Submit written report to the Project Director/COR describing proposed concrete placement program including but not limited to: transportation and placement of concrete, means and methods of consolidation, formwork and reinforcing steel installation, concrete placement sequencing and duration, means and methods to place concrete including personnel, equipment, and onsite testing agency.

1. Placement plan shall include:

a. Labor requirements.
b. Quality control requirements.
c. Placement limits.
d. Total concrete quantity.
e. Rate of concrete delivery and placement.
f. Placement plan shall include provisions for backup batching plant, pumps, vibrators, and other equipment in the event of plant or equipment failure, or unforeseen weather conditions.
g. Placement plan shall provide contingency procedures so that placement can be successfully accomplished in the event of permanent failure of a concrete pump.
h. Technical literature for equipment and methods proposed for vibrating and compacting concrete.

1) Include technical literature describing equipment including vibrator diameter, length, frequency, amplitude, centrifugal force, and manufacturer's description of radius of influence under load.
2) Where flat work is to be cast, provide similar information relative to proposed compacting screed or other method to ensure dense placement.

2. At least 14 days prior to each concrete placement, submit a plan for mixing, placing, finishing and curing concrete including the following:

   a. Methods of conveying concrete. For pumped placements of foundation mat and roof slab, minimum of two concrete pumps shall be active with additional pump present as backup. For pumped placements of foundation walls, minimum of one concrete pump shall be active with additional pump present as backup.
   b. Handling, placing, compaction, and finishing methods and equipment. Minimum of two internal vibrators shall be active for each active concrete pump with at least one backup vibrator available per pump.
   c. Concrete placement. Indicate starting point of placement, concrete delivery and placement rate, lift thicknesses and direction of advancement of concrete placement.
   d. Temperature control and monitoring methods, referencing TCP.
   e. Curing and protection methods.
   f. Target strength, slump, and proposed mixture design.
   g. Sequence and times for concrete pours.
   h. Construction joint locations and methods for preparation of construction joints.
   i. Anticipated timing, sequences, and procedures for formwork and shoring removal.

H. Concrete Qualification Plan:

1. Submit written reports to the Project Director/COR of each qualified concrete mixture demonstrating compliance with the project specifications. Report shall be prepared and sealed by professional engineer for each concrete mixture at least 15 days prior to start of work. Do not begin concrete production until the Project Director/COR has approved qualified concrete mixture materials and proportions.
2. Indicate specific materials to be utilized in each concrete mixture, including aggregates, admixtures and other materials, and amounts of mixing water to be withheld for later addition at the Project site.

I. Concrete Quality Assurance Plan: Submit written report to the Project Director/COR of proposed concrete quality assurance process to be conducted by the Contractor and sub-contractors such as Concrete Contractor, Quality Control Laboratory Testing Firm, Concrete Supplier, or others as applicable. Do not begin concrete production until the Project Director/COR has approved Concrete Assurance Plan. See Attachment E, "Quality Assurance Plan Example."

J. Thermal Control Plan: Thermal Control Plan is required for each element or group of mass concrete placements and shall be based on guidelines of ACI 207.2R. It shall demonstrate that proposed concrete mixture and methods do not result in placed concrete that exceeds specified temperature limitations. Thermal Control Plan shall be submitted to the Project Director/COR at least 14 days prior to concrete placement for review and approval. Submittal shall contain the following information:

1. Approved concrete mixture design.
2. Expected conditions at time of placement and calculated temperature rise of concrete and maximum temperature in concrete placement based on test or other data acceptable to OBO Project Director/COR. Maximum temperature limit shall be 70 deg C and maximum

temperature difference shall be 20 deg C. If maximum temperature difference is exceeded, Performance-Based Temperature Difference Limit may be proposed.

a. If Performance-Based Temperature Difference Limit other than 20 deg C is proposed, submit supporting calculations and all supporting test data for concrete mixture design used to develop temperature difference limit. Alternative temperature difference limit calculations shall clearly describe and demonstrate how alternative temperature difference limit will be implemented and used. Calculations and supplementary test data shall be submitted at a minimum of 14 calendar days for review and comment on this submittal. 20 deg C temperature difference limit shall be used until acceptance of alternative limit is provided.

3. Thermal Control Plan shall define concrete placement conditions and shall indicate anticipated ambient temperature, maximum concrete placement temperature, concrete constituent material mass and temperature, curing method, temperature monitoring and control measures.
4. Thermal Control Plan shall describe placing, monitoring of temperature, curing and thermal control procedures that will be used following concrete placement, so maximum temperature and maximum temperature differential between interior of section and outside surface of section do not exceed specified limits.
5. Proposed construction practices to maintain concrete temperature and temperature differentials within the specified limits.
6. Description of materials and procedures for insulation of mass concrete placements during thermal control.
7. Description of procedures, location, and equipment that will be used to record temperatures and temperature differences.
8. Design of cooling system, if necessary, consisting of non-corrosive piping to be embedded in mass concrete.
9. Description of measures to address and reduce excessive temperatures and temperature differences, if they occur.
10. Description of expected duration of thermal controls, and description of how thermal control period will be determined to be complete.
11. Description of curing procedures, including materials and methods, and curing duration.
12. Description of formwork removal procedures to ensure temperature difference at temporarily exposed surface will not exceed temperature difference limit, and how curing will be maintained.
13. Statement that if concrete design mixture, forms, curing method, or any other items affecting thermal control are changed, thermal control plan will be updated, submitted, and accepted prior to placing concrete.

K. Service Life Report: Service Life Report shall demonstrate that performance of structure will meet Project Requirements. Report shall account for applicable exposure conditions, utilize submitted concrete mixture proportions and materials, use results of laboratory testing, and provide results of service life modeling in tabular or graphical format. Refer to the Service Life reporting requirements in the Part 2 Article on CONCRETE MIXTURES FOR BUILDING ELEMENTS.

1. Include laboratory test reports indicating compliance with project specifications regarding durability as follows:

    a. Resistance to chloride penetration in accordance with project specifications
    b. Resistance to freeze-thawing (if applicable)
    c. Resistance to sulfate-induced deterioration from internal and external sources of sulfates
    d. Other potential durability deterioration mechanisms as indicated in the specification, if applicable.

1.5 INFORMATIONAL SUBMITTALS

A. Corporate and Personnel Qualification Data: For installer, manufacturer, and testing agency.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Aggregates.
3. Admixtures.
4. Mixing water – for non-potable sources of water, documented conformance to mandatory requirements of ASTM C1602.
5. Form materials and form-release agents.
6. Steel reinforcement and accessories.
7. Fiber reinforcement.
8. Waterstops.
9. Curing compounds.
10. Floor and slab treatments.
11. Bonding agents.
12. Adhesives.
13. Vapor retarders.
14. Semirigid joint filler.
15. Joint-filler strips.
16. Repair materials.

C. Material Test Reports: For the following, from qualified testing agency, indicating compliance with requirements as required for the structural members in the Part 2 Article on CONCRETE MIXTURES - CLASSES:

1. Alkali silica reactions in accordance with ASTM C1567.
2. Shrinkage in accordance with ASTM C157.
3. Modulus of elasticity in accordance with ASTM C469.
4. Indication of permeability of concrete in accordance with ASTM C1202.
5. Freeze-thaw durability in accordance with ASTM C457 or ASTM C666.
6. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity and comply with either of the following:

a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293 conducted by an ASTM C1077 or ISO 17025 certified laboratory within the last three years.
b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1260 conducted by ASTM C1077 or ISO 17025 certified laboratory within last twelve months.

D. Welding certificates: Demonstrate personnel compliance with Part 1 Article on QUALITY ASSURANCE.

E. Steel Reinforcement Certified Mill Test Reports: Submit Certified Mill Test Reports for each heat representing all reinforcing steel supplied to the project.

F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

G. Preconstruction Test Reports: For each mix design.

H. Concrete Pumping Program Plan: Submit written report indicating means and methods, equipment, and general activities related to transportation of fresh concrete by means of pneumatic pumps. Plan shall describe means and methods to ensure that blockage of pump line is mitigated.

1. Submit technical literature for equipment and methods proposed for use in placing concrete. Include concrete pumping or conveying equipment including type, size and material for pipe, valve characteristics, and the maximum length and height concrete will be pumped. Do not adjust the mixture design to facilitate pumping.

I. Minutes of preinstallation conference.

J. Field quality-control reports.

1.6 REPAIR SUBMITTALS

A. General:

1. Non-Conforming Materials Report (NCR). Refer to the Part 3 Article on CAST-IN-PLACE CONCRETE NON-CONFORMANCE RESOLUTION.
2. Submittal through Engineer of Record: At least 14 days before installation, the Contractor shall submit for approval, to the Engineer of Record, all applicable technical data for repair material; refer to the remaining paragraphs in this Article for potential document types. Refer to Chapter 1 of the OBO Building Code for requirements regarding signing, sealing, and dating submittals. The technical data shall include repair concrete mixture design and test results to verify satisfactory conformance to specification requirements. If proprietary material is used, manufacturer's recommended preparation, use, and installation specifications shall also be submitted.

3. Submittal to Project Director/COR: After the Engineer of Record has indicated approval on the submittal, the Contractor shall submit all applicable technical data to the OBO Project Director/COR prior to the Contractor proceeding with associated repair work.
4. Refer also to the Part 2 Article on REPAIR MATERIALS, and to the set of Part 3 Articles related to repair.

B. Shop Drawings.

C. Product Data Sheets.

D. Calculations.

E. Temporary Work: Submit Shop Drawings, calculations, and detailed design notes for any temporary works, including formwork and falsework.

F. Repair Procedures Plan: Procedures for concrete removal and repair.

G. Installation Procedures: Manufacturer's standard procedures.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project, and whose work has resulted in construction with record of successful in-service performance. As an example, installer who employs personnel on Project qualified as ACI-certified Flatwork Technician and Finisher and supervisor who is ACI-certified Concrete Flatwork Technician, or installer certified by ACI International Partner Associations as identified in Attachment D to this Section, is considered qualified.

B. Ready-Mix Concrete Manufacturer Qualifications: Firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" or similar certification program is demonstration of qualification.

C. Concrete Batch Plant Requirements: Site concrete batch plant that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

D. Professional Engineer Qualifications: Professional engineer who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for formwork and shoring/ reshoring installations similar to those indicated for this Project in material, design, and extent.

E. Testing Agency Qualifications: Independent agency, acceptable to Project Director/COR, qualified according to ASTM C 1077 or ISO 17025 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as demonstrated by experience and appropriate certification such as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or equivalent certification program. Refer to Attachment D to this Section for listing of ACI International Partner Associations for equivalent international certification programs.
2. Personnel performing laboratory tests shall be qualified as demonstrated by experience and appropriate certification such as ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I or equivalent certification program. Testing Agency laboratory supervisor shall be qualified as demonstrated by experience and appropriate certification such as ACI-certified Concrete Laboratory Testing Technician - Grade II. Refer to Attachment D to this Section for listing of ACI International Partner Associations for equivalent international certification programs.

F. Cementitious Material Source Limitations: Obtain each type or class of cementitious material of same brand from same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer. Substitution of materials during construction shall demonstrate compliance with the project specifications, demonstrate acceptable performance through the Concrete Qualification Program, and be approved by OBO.

G. Reinforcing Steel Mill Qualifications: Reinforcing bars shall be manufactured by OBO prequalified manufacturer listed in Attachment B to this Section, or by manufacturer approved by OBO based upon variance process identified in Section 1903 of the OBO Building Code.

H. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

I. Concrete Testing Services: Engage qualified independent testing agency to perform material evaluation tests and to design concrete mixtures. Approved OBO independent testing laboratories are those entities accredited by International Accreditation Services, Inc. (IAS), or inspected by Cement and Concrete Reference Laboratory (CCRL), or laboratories at OBO prequalified reinforcing steel mills, or laboratories at approved State Department of Transportation labs. See Attachment C to this Section.

1.8 CONCRETE QUALITY CONTROL PROGRAM

A. The objective of concrete quality control program is for the Contractor to outline procedures that will be used to obtain design service life for the structures. Develop and submit for approval a concrete quality control program in accordance with guidelines of ACI 121R and as specified herein. Include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of service life modeling, associated sampling and testing.

B. Develop and submit for approval a concrete quality control program in accordance with guidelines of ACI 121R and able to meet defined service life using methodology herein. Maintain copy of ACI SP-15 and CRSI 10MSP at the project site.

C. Quality Control Personnel - Submit for approval an organizational chart defining quality control hierarchy, responsibilities of various positions, including names and qualifications of individuals in those positions. Include ACI certification for the following:

1. Contractor quality control personnel responsible for inspection of concrete operations.

   a. Lead foreman of the concrete placing, finishing, and curing crews.
   b. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.
   c. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.
   d. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of specific deleterious processes and tests identified in this section. Resume shall detail the education, training and experience related to project-specific test methods and deleterious materials. Submit resume at least 20 days before examinations are to commence.
   e. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager Certification at the Plant Manager level.

D. Quality Control Manager Qualifications: Shall hold current license as professional engineer in U.S. state or territory with experience on at least five similar projects. Evidence of proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

E. Field Testing Technicians and Testing Agencies: Submit qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

1. Perform concrete work utilizing an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI SP-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI SP-2.
2. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.
3. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

F. The Contractor is responsible in the following ways for facilitating role of Contractor's Quality Control Manager in performing the activities defined below:

1. Provide access to Quality Control Manager to test concrete as indicated in the Contract Documents for compliance.
2. Place concrete only after placement of all forms, reinforcement, inserts, sleeves, and other embedments have been inspected and approved by the Contractor and Quality Control Manager and reviewed by Project Director/COR.
3. Place concrete only under supervision of Contractor and Quality Control Manager.
4. Utilize approved Quality Control Program to manage forming, reinforcement, production, delivery, placement, compaction, finishing, curing, protection and patching of all concrete.

Comply with the requirements specified in Division 01 requirements for Quality Control Manager.

5. Provide Quality Control Manager and Project Director/COR with access to site or to concrete plant to facilitate inspection of the reinforcement. Submit schedule, showing beginning and duration of shop fabrication, in sufficient time to allow for proper inspection.
6. Provide Quality Control Manager and Project Director/COR, with access to concrete plant to facilitate inspection of concrete. Notify the Quality Control Manager when production of concrete is to commence in sufficient time to allow for proper inspection.
7. Ensure that inspection and testing is performed by the Quality Control Manager in accordance with requirements of this Section and Division 01 Section "Contractor's Quality Control."
8. Provide free access to the Work and cooperate with appointed Quality Control Manager.
9. Ensure that the Quality Control Manager makes concrete compressive test specimens and perform all tests specified in this Section and Division 01.

    a. Quality Control Manager shall test proposed cement, aggregates and other concrete ingredients to ensure conformance with specified requirements.

10. Recognize authority of Quality Control Manager to reject concrete prior to or during placement for reasons of non-compliance with the Contract Documents.

1.9 TEST SECTION

A. Cast concrete slab-on-grade, walls or **[and formed-surface]**panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship. Test Sections shall be constructed using candidate, or approved, materials, mixture proportions, and concrete equipment, means and methods and other specific information outlined in the Concrete Submittal, Concrete Placement Plan, and Concrete Pumping Plan. Concrete specimens for laboratory testing for specification compliance shall be molded and tested by the Independent Quality Assurance Inspector.

1. Build panel approximately 18.0 sq. m for slab-on-grade **[and 9.0 sq. m for formed surface]**in location indicated or, if not indicated, as directed by the Project Director/COR.
2. For walls and vertical elements, construct wall panel approximately 5 m, high, 1 m wide, and 10 m long (or any length to include at least one joint) in location indicated or, if not indicated, as directed by the Project Director/COR.
3. Approved test sections may become part of the completed work if undisturbed at time of Substantial Completion.
4. Test Sections that fail to meet specification requirements will result in Non-Conformance Report issued by Independent Quality Inspector documenting the material, workmanship or other aspects demonstrating failure to meet project specifications. The Contractor shall respond to Non-Conformance report in period no longer than five working days to address items requested in Non-Conformance Report.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Permeability.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store cement, aggregate, admixture, water, embedded items and reinforcing in manner to prevent deterioration or intrusion of any foreign matter. Do not use damaged or deteriorated materials.

B. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Deliver bars to project with special bundling and tagging in accordance with CRSI Manual of Standard Practice. Tags shall be made of durable and waterproof material, marked in legible manner with waterproof markings, attached by wire, with one tag per bundle. Identification tags shall show grade of steel, mill heat number (special tagging), number of pieces, size, and mark or length of bars. **[Avoid damaging coatings on steel reinforcement. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.]**

C. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. Concrete Class: Refer to the Part 1 Article on DEFINITIONS.

B. Specified Concrete Performance: Specified limiting value of test result that indicates acceptable material quality or workmanship. Quality acceptance limits are based on design criteria that is provided as not-to-exceed values where values lower than specified indicate acceptable material (i.e., drying shrinkage); or as lower-bound limits where larger values indicate acceptable material (i.e., such as compressive strength).

C. Service Life: Government's stated expectation for number of years that the structure will function without needing major concrete rehabilitation. Service life is defined as number of years before major restoration is necessary given minimal maintenance to the structure during its life in accordance with the OBO Building Code. Major restoration is defined as extensive areas that

require extensive repairs using jack hammer or other destructive means to prepare concrete for rehabilitation. Unless otherwise specified, Service life is further defined as the summation of corrosion initiation period (Ti) and corrosion propagation period (Tp) for given concrete system.

1. Unless otherwise specified, concrete structures shall be designed for a 100-year service life, as identified in Chapter 19 of the OBO Building Code. Total service life is summation of corrosion initiation period (Ti) and corrosion propagation period (Tp). Modeling for the corrosion initiation period (Ti) shall use full probabilistic approach. Corrosion initiation time shall meet target reliability index of 1.3. Corrosion propagation period can be determined using deterministic approach.
2. Modeling of corrosion initiation time shall be in accordance with one of the following methodologies:

    a. STADIUM® software: Only certified STADIUM® laboratories and users can perform the testing and modeling.
    b. fib Bulletin 34 Model Code for Service Life Design (2006): Model used for corrosion initiation time shall be as per Appendix B2. Choice of each input parameter shall be documented in Durability Modeling Report; it shall be demonstrated how choice of input parameters is reasonable and applicable to the project. The Project Director/COR may request copy of calculations for review. Testing of concrete transport property, chloride migration coefficient, shall be in accordance with the NT Build 492 test method.

3. Deterioration mechanisms other than chloride-induced corrosion shall be considered and mitigated using deemed-to-satisfy or avoidance approach as in the specification documents.

D. ACI Publications: Comply with the following codes and standards unless modified by requirements in the Contract Documents:

1. ACI CT, “ACI Concrete Terminology”
2. ACI 301, "Specifications for Structural Concrete,"
3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
4. ACI 207.1 “Guide to Mass Concrete.”
5. ACI 211.1, “Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.”
6. ACI 303.1, “Standard Specification for Cast-in-Place Architectural Concrete.”
7. ACI 304R, “Guide for Measuring, Mixing, Transporting, and Placing Concrete.”
8. ACI 305.1, “Specification for Hot Weather Concreting.”
9. ACI 306.1, “Standard Specification for Cold Weather Concreting.”
10. ACI 308.1, “Standard Specification for Curing Concrete.”
11. ACI 309R, “Guide for Consolidation of Concrete.”
12. ACI 318M, “Building Code Requirements for Structural Concrete.”
13. ACI 347, “Guide to Formwork for Concrete.”
14. ACI 336.1, “Specification for Construction of Drilled Piers.”
15. ACI 350, “Code Requirements for Environmental Engineering Concrete Structures.”
16. ACI 365, “Service Life Prediction.”

17. ACI 562, "Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures."
18. ACI 563, "Specifications for Concrete Repair."

E. CRSI Publication: Comply with Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice, except where more stringent requirements are indicated or specified.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

   a. High-density overlay, Class 1 or better.
   b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
   c. Structural 1, B-B or better; mill oiled and edge sealed.
   d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 20 by 20 mm, minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 25 mm to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 25 mm in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars (General): ASTM A615/A615M, Grade 420 (Grade 60), deformed.

B. Low-Alloy-Steel Reinforcing Bars (Seismic Resisting Reinforcing where indicated on Drawings): ASTM A706/A706M-14, Grade 420 (Grade 60) deformed or ASTM A615/A615M-14 with the following additional requirements:

1. Actual yield strength based on mill tests shall not exceed the specified yield strength by more than 120 MPa.
2. Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
3. Minimum elongation in 8 in. shall be at least 14 percent for bar sizes No. 3 through No. 6, at least 12 percent for bar sizes No. 7 through No. 11, and at least 10 percent for bar sizes No. 14 and No. 18.

C. Prequalified Manufacturer: Reinforcing bars shall be manufactured by OBO prequalified manufacturer as indicated in Table 03300-2.2**[or the following subject to compliance with OBO Design Standards, approval of the OBO Project Director/COR, and approval of Project Director/COR; insert manufacturer's name and location]**.

D. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M epoxy coated, with less than 2 percent damaged coating in each 300-mm bar length.

E. Zinc and Epoxy Dual Coated Steel Reinforcing Bars: ASTM A1055/A1055M, Grade 420 (Grade 60), deformed.

F. Stainless Steel Reinforcing Bars: ASTM A955/A955M, Grade 60, deformed.

G. Steel Wire and Welded Wire Reinforcement, Plain and Deformed for Concrete: ASTM A1064/A1064M.

2.4 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.5 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 420 (Grade 60), plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 420 (Grade 60), plain-steel bars, ASTM A775/A775M epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

E. Mechanical Splices and Connections: As indicated on Drawings.

1. Mechanical Splice Couplers: ACI 318 (ACI 318M) [**Type 1**] [**Type 2**], same material of reinforcing bar being spliced; [**compression-only type**] [**tension-compression type**] [**dowel-bar type**] [**mechanical-lap type**].

2.6 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Monofilament or fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 25 to 56 mm long.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following :

a. Monofilament Micro-Fibers:

1) Axim Italcementi Group, Inc.; Fibrasol II P.
2) Euclid Chemical Company (The), an RPM company; Fiberstrand [**100**] [**150**].
3) FORTA Corporation; FORTA Econo-Mono.
4) Grace Construction Products, W. R. Grace & Co.; Grace MicroFiber.
5) Metalcrete Industries; Polystrand 1000.
6) Nycon, Inc.; ProConM.
7) Propex Concrete Systems Corp.; Fibermesh 150.
8) Sika Corporation; Sika Fiber PPM.
9) <**Insert manufacturer's name; product name or designation**>.

b. Fibrillated Micro-Fibers:

1) Axim Italcementi Group, Inc.; Fibrasol F.
2) Euclid Chemical Company (The), an RPM company; Fiberstrand F.
3) FORTA Corporation; FORTA [**Econo-Net**] [**Ultra-Net**].
4) Grace Construction Products, W. R. Grace & Co.; Grace Fibers.
5) Nycon, Inc.; ProConF.
6) Propex Concrete Systems Corp.; Fibermesh 300.
7) Sika Corporation; Sika Fiber PPF.
8) <**Insert manufacturer's name; product name or designation**>.

B. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 25 to 56 mm long.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. 3M; Scotchcast Polyolefin Fibers [**25 mm**] [**50 mm**].
b. Euclid Chemical Company (The), an RPM company; Tuf-Strand SF.
c. FORTA Corporation; FORTA FERRO.
d. Grace Construction Products, W. R. Grace & Co.; Strux 90/40.
e. Nycon, Inc.; XL.
f. Propex Concrete Systems Corp.; Fibermesh 650.
g. Sika Corporation; Sika Fiber [**MS**] [**MS10**].
h. <**Insert manufacturer's name; product name or designation**>.

2.7 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C150, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**]. **[Supplement with the following:**
2. Blended Hydraulic Cement: ASTM C595, [**Type IS – portland blast-furnace slag**] [**Type IP – portland-pozzolan**] [**Type IL – portland-limestone**] [**Type IT – ternary blended**].
3. Performance Cement: ASTM C1157, [**Type GU – general use**] [**Type MS – moderate sulfate resisting**] [**Type HS – high sulfate resisting**] [**Type MH – moderate head**] [**Type LH – low heat**].

a. Fly Ash: ASTM C618, Class F.
b. Slag Cement: ASTM C989, Grade [100] or [120.]

B. Normal-Weight Aggregates: ASTM C33, uniformly graded, and as follows: [**Class 3S**] [**Class 3M**] [**Class 1N**] <**Insert class**> coarse aggregate or better, graded. Provide aggregates from single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Coarse-Aggregate: Provide coarse aggregate consisting of durable particles of gravel free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, either free or as an adherent coating. Provide coarse aggregate of uniform quality throughout.

   a. General Use: Unless otherwise specified, 25 mm to 4.75 mm.
   b. Walls, Columns, Beams, and Structural Slabs: Unless otherwise specified, 20 mm to 4.75 mm.
   c. Tight Placement: Unless otherwise specified, 12.5 mm to 4.75 mm.

2. Fine Aggregate: Provide fine aggregate consisting of clean, hard, durable particles of natural or manufactured sand. Provide fine aggregate free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material. Do not use limestone dust of fracture as fine aggregate.
3. Materials that contain particles that will discolor surface shall not be used for any exposed concrete.
4. Provide aggregates from single source for exposed concrete.
5. Do not use aggregates containing chloride ions in excess to requirements of ACI for concrete construction in corrosive environments.

C. Lightweight Aggregate: ASTM C330, 20 mm nominal maximum aggregate size.

D. Water and Water Used to Make Ice: ASTM C1602/C1602M.

1. For non-potable sources of water, submit documentation on acceptability of water used as mixing water in concrete in accordance with mandatory requirements of ASTM C1602/C1602M.
2. For non-potable sources of water provide documentation for these characteristics in accordance with optional limits of ASTM C1602/C1602M: **[Chloride as Cl^- less than 500 ppm] [Chloride as Cl^- less than 1000 ppm] [Sulfate as SO_4 less than 3000 ppm] [Alkalis as (Na_2O + 0.658 K_20) less than 600 ppm] [Total solids by mass less than 50,000 ppm].**

2.8 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260.

B. Certified by manufacturer shall be compatible with other admixtures to maintain water-soluble chloride ions within limits permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride. Additionally, comply with the following, as appropriate:

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type C, Type E.
4. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
8. Corrosion-Inhibiting Admixture: ASTM C1582.

9. Class S – ASTM C494/C494M for specific use. Provide admixture manufacturer documentation for specific use and performance data.
10. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing admixture, capable of reducing water penetration of concrete exposed to hydrostatic pressure (PRAH).

    a. Permeability: Reduction of at least 50 percent in penetration shall be obtained in concretes with Permeability-Reducing Admixtures when evaluated in accordance with ACI 212.2R-14.

11. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[**free of carbon black,**] nonfading, and resistant to lime and other alkalis.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) ChemMasters.
        2) Davis Colors.
        3) Dayton Superior Corporation.
        4) Hoover Color Corporation.
        5) Lambert Corporation.
        6) QC Construction Products.
        7) Rockwood Pigments NA, Inc.
        8) Scofield, L. M. Company.
        9) Solomon Colors, Inc.
        10) <Insert manufacturer's name>.

12. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Project Director/COR from manufacturer's full range**].

2.9 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513,**[with factory-installed metal eyelets,]** for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Greenstreak.
    b. Williams Products, Inc.
    c. <**Insert manufacturer's name**>.

2. Profile: Flat, dumbbell with center bulb.
3. Dimensions: **150 mm by 10 mm thick**; nontapered.

B. Flexible PVC Waterstops: CE CRD-C 572,[**with factory-installed metal eyelets,**] for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. BoMetals, Inc.
b. Greenstreak.
c. Paul Murphy Plastics Company.
d. Vinylex Corp.
e. <**Insert manufacturer's name**>.

2. Profile: Flat, dumbbell with center bulb.
3. Dimensions: **150 mm by 10 mm thick,** nontapered.

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 20 by 25 mm.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.
b. CETCO; Volclay Waterstop-RX.
c. Concrete Sealants Inc.; Conseal CS-231.
d. Greenstreak; Swellstop.
e. Henry Company, Sealants Division; Hydro-Flex.
f. JP Specialties, Inc.; Earth Shield Type 20.
g. <**Insert manufacturer's name; product name or designation**>.

2.10 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A[**, except with maximum perm rating of** <**Insert rating**>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
b. Fortifiber Building Systems Group; Moistop Ultra [**15**] [**10**].
c. Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
d. Insulation Solutions, Inc.; Viper VaporCheck [**16**] [**10**]
e. Meadows, W. R., Inc.; Perminator [**15 mil**] [**10 mil**].
f. Raven Industries Inc.; Vapor Block [**15**] [**10**].
g. Reef Industries, Inc.; Griffolyn [**Type-105**] [**Type-65G**] [**15 mil Green**] [**10 mil Green**].

h. Stego Industries, LLC; Stego Wrap [**15 mil Class A**] [**10 mil Class A**].
i. <**Insert manufacturer's name; product name or designation**>.

B. Sheet Vapor Retarder: ASTM E 1745, Class B[**, except with maximum perm rating of** <**Insert rating**>]. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Reef Industries Inc.; Griffolyn Type-85.
b. <**Insert manufacturer's name; product name or designation**>.

C. Sheet Vapor Retarder: ASTM E 1745, Class C[**, except with maximum perm rating of** <**Insert rating**>]. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Raven Industries Inc.; Vapor Block 6.
b. Reef Industries, Inc.; Griffolyn Type-65.
c. Stego Industries, LLC; Stego Wrap, 10 mil Class C.
d. <**Insert manufacturer's name; product name or designation**>.

D. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 0.25 mm (10 mils) thick.

E. Bituminous Vapor Retarder: 2.8 mm (110 mil)- thick, semiflexible, 7-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories including bonding asphalt, pointing mastics, and self-adhering joint tape.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Meadows, W. R., Inc.; Premoulded Membrane Vapor Seal.

2. Water-Vapor Permeance: 0.00 ng/Pa x s x sq. m (0.00 grains/h x sq. ft. x inches Hg); ASTM E 154.
3. Tensile Strength: 24.5 kN/m (140 lbf/inch); ASTM E 154.
4. Puncture Resistance: 400 N (90 lbf); ASTM E 154.

F. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 38 mm (1-1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.

G. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 10 mm (3/8-inch) sieve, 10 to 30 percent passing a 0.15 mm (No. 100) sieve, and at least 5 percent passing 0.075 mm (No. 200) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

2.11 FLOOR AND SLAB TREATMENTS

A. Coordinate with Architectural Finish Schedule.

B. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing [**9.5 mm (3/8-inch)**] [**4.75 mm (No. 4)**] [**2.36 mm (No. 8)**] <**Insert size or gradation**> sieve.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; Emery.
b. Dayton Superior Corporation; Emery Tuff Non-Slip.
c. Lambert Corporation; EMAG-20.
d. L&M Construction Chemicals, Inc.; Grip It.
e. Metalcrete Industries; Metco Anti-Skid Aggregate.
f. <**Insert manufacturer's name; product name or designation**>.

C. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; A-H Alox.
b. BASF Construction Chemicals - Building Systems; Frictex NS.
c. L&M Construction Chemicals, Inc.; Grip It AO.
d. <**Insert manufacturer's name; product name or designation**>.

D. Emery Dry-Shake Floor Hardener: [**Pigmented**] [**Unpigmented**], factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.

1. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Project Director/COR from manufacturer's full range**].

E. Metallic Dry-Shake Floor Hardener: [**Pigmented**] [**Unpigmented**], factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

1. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Project Director/COR from manufacturer's full range**].

F. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. BASF Construction Chemicals - Building Systems; Maximent.
   b. ChemMasters; ConColor.
   c. Conspec by Dayton Superior; Conshake 500.
   d. Dayton Superior Corporation; Quartz Tuff.
   e. Edoco by Dayton Superior; Burke Non Metallic Floor Hardener 250.
   f. Euclid Chemical Company (The), an RPM company; Surflex.
   g. Kaufman Products, Inc.; Tycron.
   h. Lambert Corporation; Colorhard.
   i. L&M Construction Chemicals, Inc.; Quartzplate FF.
   j. Metalcrete Industries; Floor Quartz.
   k. Scofield, L. M. Company; Lithochrome Color Hardener.
   l. Symons by Dayton Superior; Hard Top.
   m. <**Insert manufacturer's name; product name or designation**>.

G. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. BASF Construction Chemicals - Building Systems; Mastercron.
   b. ChemMasters; ConColor.
   c. Conspec by Dayton Superior; Conshake 600 Colortone.
   d. Dayton Superior Corporation; Quartz Tuff.
   e. Edoco by Dayton Superior; Burke Non Metallic Floor Hardener 200 - 205.
   f. Euclid Chemical Company (The), an RPM company; Surflex.
   g. Kaufman Products, Inc.; Tycron.
   h. Lambert Corporation; Colorhard.
   i. L&M Construction Chemicals, Inc.; Quartz Plate FF.
   j. Metalcrete Industries; Floor Quartz.
   k. Scofield, L. M. Company; Lithochrome Color Hardener.
   l. Symons by Dayton Superior; Color Hardener.
   m. <**Insert manufacturer's name; product name or designation**>.

2. Color: [**As indicated by manufacturer's designation**] [**Match Architect's sample**] [**As selected by Project Director/COR from manufacturer's full range**].

2.12 LIQUID FLOOR TREATMENTS

A. Coordinate with Architectural Finish Schedule.

B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ChemMasters; Chemisil Plus.
b. ChemTec Int'l; ChemTec One.
c. Conspec by Dayton Superior; Intraseal.
d. Curecrete Distribution Inc.; Ashford Formula.
e. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
f. Edoco by Dayton Superior; Titan Hard.
g. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
h. Kaufman Products, Inc.; SureHard.
i. L&M Construction Chemicals, Inc.; Seal Hard.
j. Meadows, W. R., Inc.; LIQUI-HARD.
k. Metalcrete Industries; Floorsaver.
l. Nox-Crete Products Group; Duro-Nox.
m. Symons by Dayton Superior; Buff Hard.
n. US SPEC, Division of US Mix Products Company; US SPEC Industraseal.
o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear.
p. <**Insert manufacturer's name; product name or designation**>.

C. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Advanced Floor Products; Retro-Plate 99.
b. L&M Construction Chemicals, Inc.; FGS Hardener Plus.
c. QuestMark, a division of CentiMark Corporation; DiamondQuest Densifying Impregnator Application.
d. <**Insert manufacturer's name; product name or designation**>.

2.13 CURING MATERIALS

A. Evaporation Retarder: Apply waterborne monomolecular evaporation retarder to concrete surfaces, as recommended by ACI 302, ACI 305, ACI 308, and ACI 345 if hot, dry, or windy weather conditions cause moisture loss greater than 0.75 kg/m2/hr as determined using Menzel Evaporation Rate chart. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before final finishing operations. Evaporation rate calculations will be confirmed by the Engineer. Failure to use evaporation retarder will be grounds for rejection of concrete. The Engineer shall approve all evaporation

retarding materials. Evaporation retarders are not required where water fogging equipment is in use.

B. Absorptive Cover: Compliant with AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 300 g/sq. m (9 oz./sq. yd.) when dry.

C. Liquid Curing Compounds: Compliant with ASTM C309 or ASTM C1315

D. Moisture-Retaining Cover: Compliant with ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

E. Water: Compliant with ASTM C1602 and ASTM D512.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. BASF Construction Chemicals - Building Systems; Kure 200.
c. ChemMasters; Safe-Cure Clear.
d. Conspec by Dayton Superior; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
f. Edoco by Dayton Superior; Res X Cure WB.
g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
h. Kaufman Products, Inc.; Thinfilm 420.
i. Lambert Corporation; AQUA KURE - CLEAR.
j. L&M Construction Chemicals, Inc.; L&M Cure R.
k. Meadows, W. R., Inc.; 1100-CLEAR.
l. Nox-Crete Products Group; Resin Cure E.
m. Right Pointe; Clear Water Resin.
n. SpecChem, LLC; Spec Rez Clear.
o. Symons by Dayton Superior; Resi-Chem Clear.
p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
r. <**Insert manufacturer's name; product name or designation**>.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; AH Clear Cure WB.
b. BASF Construction Chemicals - Building Systems; Kure-N-Seal WB.
c. ChemMasters; Safe-Cure & Seal 20.

d. Conspec by Dayton Superior; Cure and Seal WB.
e. Cresset Chemical Company; Crete-Trete 309-VOC Cure & Seal.
f. Dayton Superior Corporation; Safe Cure and Seal (J-18).
g. Edoco by Dayton Superior; Spartan Cote WB II.
h. Euclid Chemical Company (The), an RPM company; Aqua Cure VOX; Clearseal WB 150.
i. Kaufman Products, Inc.; Cure & Seal 309 Emulsion.
j. Lambert Corporation; Glazecote Sealer-20.
k. L&M Construction Chemicals, Inc.; Dress & Seal WB.
l. Meadows, W. R., Inc.; Vocomp-20.
m. Metalcrete Industries; Metcure.
n. Nox-Crete Products Group; Cure & Seal 150E.
o. Symons by Dayton Superior; Cure & Seal 18 Percent E.
p. TK Products, Division of Sierra Corporation; TK-2519 WB.
q. Vexcon Chemicals, Inc.; Starseal 309.
r. <**Insert manufacturer's name; product name or designation**>.

H. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals - Building Systems; Kure-N-Seal W.
b. ChemMasters; Safe-Cure Clear.
c. Conspec by Dayton Superior; High Seal.
d. Dayton Superior Corporation; Safe Cure and Seal (J-19).
e. Edoco by Dayton Superior; Spartan Cote WB II 20 Percent.
f. Euclid Chemical Company (The), an RPM company; Diamond Clear VOX; Clearseal WB STD.
g. Kaufman Products, Inc.; SureCure Emulsion.
h. Lambert Corporation; Glazecote Sealer-20.
i. L&M Construction Chemicals, Inc.; Dress & Seal WB.
j. Meadows, W. R., Inc.; Vocomp-20.
k. Metalcrete Industries; Metcure 0800.
l. Nox-Crete Products Group; Cure & Seal 200E.
m. Symons by Dayton Superior; Cure & Seal 18 Percent E.
n. Vexcon Chemicals, Inc.; Starseal 0800.
o. <**Insert manufacturer's name; product name or designation**>.

I. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals - Building Systems; Kure-N-Seal 25 LV.

b. ChemMasters; Spray-Cure & Seal Plus.
c. Conspec by Dayton Superior; Sealcure 1315.
d. Dayton Superior Corporation; Day-Chem Cure and Seal (J-22UV).
e. Edoco by Dayton Superior; Cureseal 1315.
f. Euclid Chemical Company (The), an RPM company; Super Diamond Clear; LusterSeal 300.
g. Kaufman Products, Inc.; Sure Cure 25.
h. Lambert Corporation; UV Super Seal.
i. L&M Construction Chemicals, Inc.; Lumiseal Plus.
j. Meadows, W. R., Inc.; CS-309/30.
k. Metalcrete Industries; Seal N Kure 30.
l. Right Pointe; Right Sheen 30.
m. Vexcon Chemicals, Inc.; Certi-Vex AC 1315.
n. <**Insert manufacturer's name; product name or designation**>.

J. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. Products: Subject to compliance with requirements**,** available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals - Building Systems; Kure 1315.
b. ChemMasters; Polyseal WB.
c. Conspec by Dayton Superior; Sealcure 1315 WB.
d. Edoco by Dayton Superior; Cureseal 1315 WB.
e. Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; LusterSeal WB 300.
f. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
g. Lambert Corporation; UV Safe Seal.
h. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
i. Meadows, W. R., Inc.; Vocomp-30.
j. Metalcrete Industries; Metcure 30.
k. Right Pointe; Right Sheen WB30.
l. Symons by Dayton Superior; Cure & Seal 31 Percent E.
m. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.
n. <**Insert manufacturer's name; product name or designation**>.

2.14 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: [ASTM D 1751, asphalt-saturated cellulosic fiber][or][ASTM D 1752, cork or self-expanding cork].

B. Epoxy Joint Filler: For control and construction joints of slab-on-grade in warehouses, a two component, 100 percent solids, low-range tensile strength semi-rigid epoxy with a minimum shore D hardness 50 (ASTM D676) and elongation of 6 percent (ASTM D 2240). Epoxy joint filler shall be mixed and installed in strict accordance with direction of manufacturer. Joint filler shall not be filled sooner than 90 days after slab placement.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. **[Types I and II, non-load bearing][Types IV and V, load bearing]**, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.56 mm (26 gage, 0.022 inch) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.86 mm (22 gage, 0.034 inch) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.15 REPAIR MATERIALS

A. General:

1. Only one brand of proprietary concrete repair material shall be used in any single repair operation unless compatibility between brands can be proven with actual test or performance data.
2. Conventional concrete mix to be used as replacement concrete repair material shall be ready-mix concrete that conforms to all salient features for repair material identified in this Article and shall conform to ASTM C94.
3. The Contractor is responsible for selection and correct application of concrete repair material. Refer to the Part 1 Article on REPAIR SUBMITTALS.
4. Salient Features for Concrete Repair Material: Material shall conform to all of the following:

   a. Shall be a cementitious material that after hardening will remain stable in wet and moist environments and will not dissolve in water.
   b. Have 28-day compressive strength of 30 MPa or greater when tested according to ASTM C39, unless otherwise specified.
   c. Bond strength of repair material shall be tested in accordance with ASTM C882 procedures for type V material and shall have the minimum strength of 7 MPa at 28 days of age unless otherwise specified.
   d. Shall be suitable for application at the minimum temperature of 12 deg C.
   e. Shall not contain chlorides, added gypsum, added lime, or high alumina cements. Shall be noncombustible both before and after cure.
   f. Color shall be concrete gray unless otherwise specified.
   g. Shall not produce a vapor barrier material and shall be thermally compatible with concrete.

h. Shall have a freeze-thaw resistance equal to or greater than the concrete substrate, air-entrained concrete designed for severe exposure conditions according to substrate concrete, unless otherwise specified.
i. Shall have drying shrinkage performance comparable to concrete substrate or maximum length change of 0.40 percent at 28 days of age when tested in accordance with ASTM C157.

B. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 3 mm and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 3 to 6 mm or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 30 MPa at 28 days when tested according to ASTM C 109/C 109M.

C. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 6 mm and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 3 to 6 mm or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 35 MPa at 28 days when tested according to ASTM C 109/C 109M.

D. Epoxy Crack Injection Adhesive: ASTM C 881/C 881M, Type [I,] [IV,] [Grade 1,] [except for gel time,] [solvent free].

2.16 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each class and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use qualified independent testing agency acceptable to the Project Director/COR for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
2. Do not use same testing agency for field quality control testing.

B. Cementitious Materials: Unless otherwise approved, of cementitious materials proportions for cast-in-place concrete shall meet one of the following:

1. Fly Ash: Maximum replacement of 40 percent by mass of total cementitious.
2. Combined Fly Ash, metakaolin, and Pozzolan: maximum replacement of 25 percent by mass of total cementitious.
3. Slag Cement: Maximum replacement of 80 percent by mass of total cementitious.
4. Silica Fume: Maximum replacement of 10 percent by mass of total cementitious.
5. Combined Fly Ash, metakaolin or Pozzolans, Slag Cement, and Silica Fume: maximum replacement of 50 percent by mass of total cementitious;

    a. With fly ash, metakaolin or pozzolans: not exceeding 25 percent by mass of total cementitious;
    b. And silica fume not exceeding 10 percent by mass of total cementitious.

6. Alternative cementitious materials combinations that can demonstrate compliance with project specifications can be accepted.
7. Silica Fume: Maximum replacement of 7 percent by mass of total cementitious.
8. Use of silica fume requires demonstration of adequate dispersion in concrete prior to acceptance. Contractor shall demonstrate that trial batch of proposed concrete mixture utilizing silica fume conforms to specified fresh and hardened concrete properties. Additionally, petrographic examination of concrete specimen sampled from trial batch shall be conducted and demonstrate that silica fume has been homogeneously dispersed in concrete.

C. Limit water-soluble, chloride-ion content in hardened concrete to the following limits depending on exposure category assigned to the structural member in the Part 2 Article on CONCRETE MIXTURES – CLASSES. Limits are stated in terms of chloride ions in percent weight of cement.

1. Prestressed and post-tensioned concrete for all exposure categories: [**0.06**].
2. Reinforced concrete in Exposure Category C0: [**1.00**].
3. Reinforced concrete in Exposure Category C1: [**0.30**].
4. Reinforced concrete in Exposure Category C2: [**0.15**].

D. Admixtures: Use admixtures according to manufacturer's written instructions.

E. Specialized materials such as ASTM C494 Type S, carbon dioxide injection, or similar, shall require demonstration of compliance with project specifications prior to its approval and use.

1. Use **[water-reducing] [high-range water-reducing] [or] [plasticizing]** admixture in concrete, as required, for placement and workability.
2. Use **[air-entraining]** admixtures to achieve the necessary air content for freeze-thawing and salt-scaling resistance.
3. Use water-reducing or retarding admixtures when required to ensure adequate transportation, placement, and consolidation of concrete mixtures as specified in Concrete Placement Report.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
5. Concrete mixtures containing corrosion-inhibiting admixtures will require trial batching to demonstrate that they can be transported and placed adequately by mitigating accelerating effect of corrosion-inhibiting admixture. See paragraph on slump retention in the Part 2 Article on CONCRETE MIXING.

F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

G. Additional Requirements: Provide documentation in submittal prior to commencement of Work when required for concrete mixtures designed for structural members identified in the Part 2 Article on CONCRETE MIXTURES – CLASSES.

1. Alkali Silica Reactivity:

   a. Submit documentation of aggregate with satisfactory service record for minimum ten-year period used in concrete with similar cementitious materials or with an alkali (Na2O eq.) content in concrete equal or higher than that in the proposed mixture.
   b. Submit ASR test results of all aggregates proposed for use in concrete; aggregates with mortar bar expansion at 14 days in exposure solution, in accordance with ASTM C1260, less than or equal to 0.10 percent or expansion of concrete prisms at 1 year, in accordance with ASTM C1293, less than or equal to 0.04 percent shall be considered non-reactive and do not need additional testing described in the immediately following subparagraph.
   c. In the absence of service record, or when test results of aggregates indicate potential for deleterious expansion by criteria identified in the immediately preceding subparagraph, provide documentation of tests conducted with cementitious materials and aggregates proposed for Work – ASTM C1567 14-day expansion less than or equal to 0.10 percent. Each aggregate type shall be tested separately.

2. Shrinkage: Provide documentation of tests of concrete conducted in accordance with ASTM C157 for specimens cured for **[7 days in water and placed in drying environment for 21 days]** – length change should be less than **[0.05 percent at 28 days]** age.
3. Modulus of Elasticity: Provide documentation of tests of concrete conducted in accordance with ASTM C469 for specimens cured for 28 days for a modulus of elasticity greater than ***<specify Ec required by design>***.
4. Rapid Chloride Permeability: Provide documentation of the tests of concrete conducted in accordance with ASTM C1202 for specimens cured for 7 days at 23 deg C (73 deg F) and 21 days at 38 deg C (100 deg F) to achieve value equal to or less than specified rapid chloride permeability (RCP) for class of concrete for building elements identified in the Part 2 Article on CONCRETE MIXTURES – CLASSES.
5. Freeze-thaw testing: For structural members indicated in the Part 2 Article on CONCRETE MIXTURES – CLASSES, submit documentation of tests of concrete conducted in accordance with ASTM C666 for a minimum durability factor of 60 percent at 300 cycles. Alternatively provide documentation that spacing factor of air void system of concrete specimens is less than 0.25 mm (0.010 inches).

2.17 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Concrete Mixture Proportions – At least 60 days prior to concrete placement, submit concrete mixture proportions, ingredient material certificates and test data, and trial batch test data for each concrete mixture proposed. Indicate where each mixture will be used when more than one mixture design is submitted. Obtain approval from the Contracting Officer prior to placement.

B. Concrete Design Requirements.

1. Proportion concrete mixtures to conform to requirements listed in Project Documents in accordance with procedures outlined in ACI 201.2R and ACI 211.1.
2. Develop mixture proportions for concrete to produce required design compressive strength (f'c), drying shrinkage, and constructability for mixtures that have potential to accomplish a structure with design service life.

C. Concrete Mixture Qualifications – Previously Approved Concrete Mixtures.

1. For identical concrete mixtures previously approved for use within the past 18 months, previous mixture qualification submittal may be re-submitted without further trial batch testing if accompanied by:

    a. Copy of prior approvals indicating the project name, project number, and location.
    b. Ingredient material test data conducted within 6 months of submittal date.
    c. Copies of previously approved trial batch test data.
    d. Log containing at least 15 sequential test results with calculated mean and standard deviation of production concrete for air content, compressive strength and concrete transport properties.

2. If changes are made to material type, class, sources, or suppliers; chemical composition; and/or mixture proportions, then submit written opinion of significance of the change(s). Change(s) may require additional testing at discretion of the Project Director/COR in consultation with the Government's Subject Matter Expert in Concrete Materials.

D. Concrete Mixture Qualifications – New Concrete Mixtures.

1. For new concrete mixtures without previous approval or without historic records of performance, new concrete mixture qualification submittal shall include:

    a. Submit complete ingredient material test data, including applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes.
    b. Submit copies of test reports by independent test lab conforming to ASTM C1077 or ISO 17025 showing that mixture has been successfully tested to produce concrete with properties specified and that mixture will be suitable for job conditions as described. Submit test reports along with concrete mixture proportions. Obtain approval before concrete placement.
    c. Test a minimum of two trial batches of production concrete to establish specified transport properties. If batching facilities are located such that haul-time will exceed 30 minutes, include simulated haul time in trial batch.
    d. If concrete mixture is proposed to contain corrosion inhibitors then accomplish laboratory testing and test for transport properties with and without the corrosion inhibitor because corrosion inhibitors are known to distort results of service life modeling when compared to mixtures without corrosion inhibitors. Obtain approval from the Project Director/COR for use of corrosion inhibitors.

2. Test and report fresh concrete property tests of each trial batch as follows:

   a. Slump in accordance with ASTM C143/C143M.
   b. If using self-consolidating concrete, slump flow in accordance with ASTM C1611/C1611M.
   c. Air content in accordance with ASTM C231/C231M or ASTM C173/C173M.
   d. Unit weight in accordance with ASTM C138/C138M.
   e. Temperature in accordance with ASTM C1064/C1064M.

3. Cast specimens, test, and report hardened concrete property tests of each trial batch as follows:

   a. Compressive strength at 7, 28, and 56 days of both batches in accordance with ASTM C39/C39M. Use of unbonded caps in accordance with ASTM C1231/C1231M is permitted.
   b. Drying shrinkage in accordance with ASTM C157 shall be determined from at least one batch.
   c. Tensile strength in accordance with ASTM C496 shall be determined using specimens cast from at least one batch.
   d. Freeze-thaw durability factor in accordance with ASTM C666, if required, as the mean of three test specimens cast from at least one batch.
   e. Initial chloride ion content in accordance with ASTM C1218 determined from at least one batch.
   f. Spacing factor determined in accordance with ASTM C457, if required, from at least one batch.
   g. Scaling resistance in accordance with ASTM C672, if required, from at least one batch.

4. Moist cure concrete intended for cast-in-place applications in accordance with standard moist curing conditions described in ASTM C192/C192M unless otherwise specified. Moist cure concrete intended for precast applications in manner proposed for use on the project.

E. Service Life Qualification – Testing

1. If using STADIUM® methodology: Cast twelve 4 by 8 inch cylinders, test and report ion transport properties as follows:

   a. Determine porosity at 28-days and 90-days of standard moist curing. Calculate the mean porosity and standard deviation at each test age.
   b. Determine Doh at 28-days and 90-days of standard moist curing. Calculate the mean Doh and standard deviation at each test age.
   c. Determine MTC at 28-days of standard moist curing.
   d. Calculate aging coefficient as ratio of the mean 90-day, or longer, Doh to the mean 28-day standard moist cure Doh.
   e. Retain unused specimens in storage.

f. These specimens may be tested later to refine actual aging factor. This is required in the event that any production concrete falls short of service life as it will provide evidence to better predict service life.

2. If using fib Bulletin 34 methodology: Cast six 100 by 200 mm (4 by 8 inch) cylinders from same concrete batch, test and report ion transport properties as follows:

   a. Determine the chloride migration coefficient at 28 days as NT Build 492 test procedure.
   b. Determine the acid-soluble chloride content at 28 days per ASTM C1152.

3. Special handling will be necessary for shipments of transport property specimens. These cylinders shall be wrapped completely with slightly damp paper towels with distilled water only. Wrapped cylinders shall be placed in either vacuum package or double layers of sealed plastic bags. Package test cylinders to prevent damage and ship to approved testing laboratory.

F. Service Life Report: The Contractor shall submit Durability Modeling report prepared by the consultant that conducts service life assessment of proposed concrete system for each concrete mixture. Refer additionally to summary requirements for this report in the Part 1 Article on ACTION SUBMITTALS. As a minimum, report shall contain:

1. Concrete mixture proportions.
2. Concrete cover to reinforcing steel. Cover to all reinforcing bars shall be clearly delineated with allowance for placement tolerances per ACI 117.
3. Environmental exposure conditions used for each type of concrete member.
4. Concrete transport properties and materials characteristics that, for specified exposure zones, satisfies minimum required service life of the structural member.
5. Narrative describing modeling process including assumptions and recommendations to accomplish service life using quality concrete and specified cover. In the event that locally available materials cannot be shown to accomplish the service life then the Contractor shall prepare proposal for review by OBO's Subject Matter Expert in Concrete Materials and approval by the Project Director/COR to use alternative sources of materials and/or supplemental corrosion protections
6. A cover letter signed and stamped by registered Professional Engineer certifying compliance with present specification, including required average compressive strength (f'cr), drying shrinkage, transport properties, and constructability, for mixtures that have potential to accomplish a structure with design service life.
7. If using STADIUM® methodology: Letter regarding certificate of completion for STADIUM® training.
8. Accreditation Certification letter for laboratory including all test methods utilized.

G. For concrete mixtures that are proposed to contain corrosion inhibitors, the Contractor shall submit 28-day values for transport properties (Doh for STADIUM® or chloride migration coefficient for fib Bulletin 34) from at least three batches of the mixture with and without admixture making appropriate adjustments to maintain constant water to cementitious ratio. The purpose is to establish a correlation with respect to adjusted value for production tested values.

H. At the option of the Contractor, a revised service life submittal may be provided as a value engineering proposal using refined characteristic properties calculated from production data. Extensions to corrosion propagation period may be reviewed by OBO's Subject Matter Expert in Concrete Materials and approved by the Project Director/COR based on evidence provided by the Contractor on a case-by-case basis.

2.18 CONCRETE MIXTURES – CLASSES

A. Unless otherwise specified, comply with the requirements shown in Table 2.18 "Concrete Classes" and described in this Section.

1. [Specified Chloride Permeability: [2500 coulombs] [2000 coulombs] [1500 coulombs].]

TABLE 2.18 – CONCRETE CLASSES

Concrete Class	Durability Exposure F	S	W	C	Min. Strength, f'c MPa	Specified Age, Days	Max. w/cm ratio	[RCP, coulombs]	Max. Shrinkage Limit	Modulus, MPa	Special Require-ments
Civil Site and Perimeter	2	0	1	1	25	56	0.45		0.04%		Air
Footings and Foundations	0	0	1	0	35	56	0.40				
Foundation Walls	0	0	0	0	35	56	0.40		0.04%		
Exterior Slab-on Grade	2	0	1	2	35	56	0.40		0.04%		Air; Synthetic Fibers
Interior Slab-on-Grade	0	0	0	0	28	56	0.40		0.04%		Synthetic Fibers
Suspended Slabs	0	0	0	0	35	56	0.40		0.04%		
Building Walls and Frame	0	0	0	0	35	56	0.40				
Toppings	0	0	0	0	35	56	0.40				Synthetic Fibers

TABLE 2.18 – CONCRETE CLASSES

Concrete Class	Durability Exposure F	S	W	C	Min. Strength, f'c MPa	Specified Age, Days	Max. w/cm ratio	[RCP, coulombs]	Max. Shrinkage Limit	Modulus, MPa	Special Require-ments
Garage Walls, Suspended Slabs	2	0	1	2	35	56	0.40				
Mass Concrete					35	56	0.45				
Specialized Concrete											

B. **Class Civil/Site and Perimeter Walls**: Proportion normal-weight concrete mixture as follows:

1. Minimum Design Compressive Strength: As indicated in Contract Documents at the age of 28 days.
2. Minimum Design Compressive Strength – Mass Concrete: Compressive strength of concrete members designated as mass concrete can be achieved at an age of 56 days.
3. Maximum Water-Cementitious Materials Ratio **[0.45]** or as indicated in approved Concrete Mixture Submittal.
4. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
5. Drying Shrinkage: Drying shrinkage of prism specimens determined in accordance with ASTM C157 shall not be greater than 0.050 percent (75x75 mm cross section) or 0.040 percent (100x100 mm cross section) after 28 days of drying. Specimens shall be moist cured for 7 days prior to initiation of drying and length change shall be calculated using length after moist curing as reference length.
6. Air Content: As indicated in ACI 301 for the corresponding maximum aggregate size.
7. Spacing Factor: Not greater than 0.2 mm when determined in accordance with ASTM C457 Method B.
8. Specific Surface: Not less than 20 mm^2/mm^3 when determined in accordance with ASTM C457 Method B.

C. **Class Footings/Foundations:** Proportion normal-weight concrete mixture as follows:

1. Minimum Design Compressive Strength: As indicated in Contract Documents at age of 28 days.
2. Minimum Design Compressive Strength – Mass Concrete: Compressive strength of concrete members designated as mass concrete can be achieved at an age of 56 days.

3. Maximum Water-Cementitious Materials Ratio: **[0.40]** or as indicated in approved Concrete Mixture Submittal.
4. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
5. Foundations in direct contact with soil shall require use of concrete mixture with at least 35 MPa at 28 days and at least 30 percent replacement of portland cement by supplementary cementitious materials. Alternative replacement levels can be acceptable provided that expansion at 6 months is less than 0.05 percent when tested in accordance with ASTM C1012.
6. Concrete cover shall be at least 75 mm for concrete members in direct contact with soil.
7. Air Content: As indicated in ACI 301 for corresponding maximum aggregate size.
8. Spacing Factor: Not greater than 0.2 mm when determined in accordance with ASTM C457 Method B.
9. Specific Surface: Not less than 20 mm^2/mm^3 when determined in accordance with ASTM C457 Method B.

D. **Class Foundation Walls** (Foundation Walls extend a minimum of 1.00 m above adjacent grade): Proportion normal-weight concrete mixture as follows:

1. Minimum Design Compressive Strength: As indicated in Contract Documents at age of 28 days.
2. Minimum Design Compressive Strength – Mass Concrete: Compressive strength of concrete members designated as mass concrete can be achieved at an age of 56 days.

3. Maximum Water-Cementitious Materials Ratio: **[0.40]** or as indicated in approved Concrete Mixture Submittal.
4. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
5. Drying Shrinkage: Drying shrinkage of prism specimens determined in accordance with ASTM C157 shall not be greater than 0.050 percent (75 x 75 mm cross section) or 0.040 percent (100x100 mm cross section) after 28 days of drying. Specimens shall be moist cured for 7 days prior to initiation of drying and length change shall be calculated using length after moist curing as reference length.
6. Foundation walls in direct contact with soil require the use of concrete mixture with at least 35 MPa at 28 days and at least 30 percent replacement of portland cement by supplementary cementitious materials. Alternative replacement levels may be acceptable provided that expansion at 6 months is less than 0.05 percent when tested in accordance with ASTM C1012.
7. Air Content: As indicated in ACI 301 for corresponding maximum aggregate size.
8. Spacing Factor: Not greater than 0.2 mm when determined in accordance with ASTM C457 Method B.
9. Specific Surface: Not less than 20 mm^2/mm^3 when determined in accordance with ASTM C457 Method B.

E. **Class Slabs-on-Grade:** Proportion normal-weight concrete mixture as follows:

1. Minimum Design Compressive Strength: As indicated in Contract Documents at the age of 28 days.
2. Minimum Design Compressive Strength – Mass Concrete: Compressive strength of concrete members designated as mass concrete can be achieved at an age of 56 days.

3. Maximum Water-Cementitious Materials Ratio: **[0.45]** or as indicated in approved Concrete Mixture Submittal.
4. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
5. Drying Shrinkage: Drying shrinkage of prism specimens determined in accordance with ASTM C157 shall not be greater than 0.050 percent (75x75 mm cross section) or 0.040 percent (100x100 mm cross section) after 28 days of drying. Specimens shall be moist cured for 7 days prior to the initiation of drying and the length change shall be calculated using the length after moist curing as the reference length.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Synthetic-micro-fiber dosage rates in first subparagraph below reflect typical recommendations of manufacturers. Retain first option for minimum dosage of synthetic micro-fiber used for reducing plastic shrinkage cracking. Retain second option or increase dosage for synthetic micro-fiber used for improving hardened concrete properties.
8. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at dosage indicated in concrete mixture submittal. Ensure that dispersion of the fibers has been achieved through laboratory testing.

F. **Class Suspended Slabs:** Proportion normal-weight concrete mixture as follows:

1. Minimum Design Compressive Strength: As indicated in Contract Documents at age of 28 days.
2. Minimum Design Compressive Strength – Mass Concrete: Compressive strength of concrete members designated as mass concrete can be achieved at an age of 56 days.

3. Maximum Water-Cementitious Materials Ratio: **[0.45]** or as indicated in approved Concrete Mixture Submittal.
4. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
5. Drying Shrinkage: Drying shrinkage of prism specimens determined in accordance with ASTM C157 shall not be greater than 0.040 percent (75x75 mm cross section) or 0.030 percent (100x100 mm cross section) after 28 days of drying. Specimens shall be moist cured for 7 days prior to the initiation of drying and length change shall be calculated using length after moist curing as reference length.

G. **Class Building Walls and Frame Members:** Proportion normal-weight concrete mixture as follows:

1. Minimum Design Compressive Strength: As indicated in Contract Documents at age of 28 days.
2. Minimum Design Compressive Strength – Mass Concrete: Compressive strength of concrete members designated as mass concrete can be achieved at an age of 56 days.
3. Maximum Water-Cementitious Materials Ratio: [**0.45**] or as indicated in approved Concrete Mixture Submittal.
4. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
5. Drying Shrinkage: Drying shrinkage of prism specimens determined in accordance with ASTM C157 shall not be greater than 0.040 percent (75x75 mm cross section) or 0.030 percent (100x100 mm cross section) after 28 days of drying. Specimens shall be moist cured for 7 days prior to initiation of drying and length change shall be calculated using length after moist curing as reference length.

H. **Class Concrete Toppings:** Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: As indicated in Contract Documents at the age of 28 days.

2. Maximum Water-Cementitious Materials Ratio: **[0.45]** or as indicated in approved Concrete Mixture Submittal.
3. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
4. Slump Limit: As indicated in submittal.
5. Air Content: Do not allow air content of trowel-finished toppings to exceed 3 percent.
6. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 0.90 kg/cu. m (1.5 lb/cu. yd).

I. Class Garage Walls, Suspended Slabs, and Building Frame Members: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: As indicated in Contract Documents at the age of 28 days.

2. Maximum Water-Cementitious Materials Ratio: [**0.45**] or as indicated in approved Concrete Mixture Submittal.
3. Water-Cementitious Materials Ratio Tolerance: - 0.03 / + 0.00
4. Air Content: As indicated in ACI 301 for corresponding maximum aggregate size.
5. Spacing Factor: Not greater than 0.2 mm when determined in accordance with ASTM C457 Method B.
6. Specific Surface: Not less than 20 mm^2/mm^3 when determined in accordance with ASTM C457 Method B

J. **Class Specialized Concrete:** Concrete mixtures designated as Specialized Concrete shall include, but not limited to, the following:

1. Self-Consolidating Concrete: Fresh concrete that can flow around reinforcement and consolidate within formwork under its own weight without vibration.
2. Low-Carbon Embodied Concrete: Concrete mixtures utilizing least amount of portland cement and maximum amount of supplementary cementitious materials. Other technologies such as carbon dioxide injection, curing or similar may be acceptable by Project Director/COR.
3. Mass Concrete: Concrete mixtures designed to generate least amount of heat possible during strength development. See Thermal Control.
4. High-Strength Concrete: Concrete that has specified compressive strength for design of 55 MPa or greater.
5. High-Performance Concrete: Concrete meeting special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices.
6. Shrinkage-Compensating Concrete: Concrete containing expansive components usually based on formation of calcium sulfoaluminate (ettringite) in mixture of calcium aluminate and gypsum.

7. Performance requirements for each Specialized Concrete shall meet the Service Life and other applicable requirements indicated in Contract Documents unless otherwise approved by Project Director/COR.

2.19 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M**[and ASTM C 1116/C 1116M]** and furnish batch ticket information. Comply with one of the following:

1. Ready-mix concrete producer shall be an NRMCA certified provider, or be subject to an inspection by an NRMCA certified inspector and approved by the OBO Project Director/COR.

   a. Each plant and truck mixer shall be currently certified by NRMCA or have inspection report signed and sealed by licensed Professional Engineer showing concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C94. A new certification or signed and sealed report is required every time a plant is moved. Plants with licensed Professional Engineer's inspection require re-inspection every 2 years. Submit copy of certification or signed and sealed inspection report. Remove equipment or facilities from service until corrected when they fail to meet specification requirements.
   b. Concrete trial batches are required each time a different source of concrete materials constituents (i.e., cement, supplementary cementitious materials, aggregates, or admixtures) is selected for ready-mix concrete production.
   c. A batch ticket is required for each ready-mix concrete truck arriving on-site. Batch ticket shall contain the following:

      1) Date and truck number
      2) Ticket number
      3) Mixture designation of concrete
      4) Cubic yards of concrete
      5) Cement brand, type and weight in pounds
      6) Weight in pounds of fine aggregate (sand)
      7) Weight in pounds of coarse aggregate (stone)
      8) Air entraining agent, brand, and weight in pounds and ounces
      9) Other admixtures, brand, and weight in pounds and ounces
      10) Water, in gallons, stored in attached tank
      11) Water, in gallons, maximum that can be added without exceeding design water/cementitious materials ratio
      12) Water, in liters, actually used (by truck driver)
      13) Time of loading
      14) Time of delivery to job (by truck driver)
      15) Time of discharge

d. Any truck delivering concrete to the job site that is not accompanied by delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.

2. Fresh concrete shall be provided at a rate sufficient to ensure that placed concrete does not begin to set prior to integration with fresh concrete. Cold joints are cause for rejection.
3. When air temperature is between 30 and 32 deg C, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 32 deg C, reduce mixing and delivery time to 60 minutes. Alternatively, conduct a slump retention evaluation.
4. Slump Retention Evaluation: Conduct slump retention evaluation at ready-mix or mobile concrete batch plant. Slump retention shall consist of batching of qualified concrete mixture using various dosages of retarding, hydration stabilizing, or workability extension admixtures, over period of time not less than 120 minutes. Determine slump, air content, unit weight and temperature of concrete immediately after batching, and in 30-minute intervals until concrete slump is less than 50 mm (2 inches) or after 120 minutes. The initial slump immediately after batching shall not exceed maximum tolerance of slump as indicated in concrete mixture submittal. Submit written report showing concrete mixture, batch ticket, and testing results of slump retention evaluation to the Project Director/COE. The report shall explicitly state maximum delivery time proposed by the Contractor and Concrete Producer to ensure that concrete can be adequately placed and consolidated on the basis of slump retention evaluation

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 0.75 cu. m or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 0.75 cu. m, increase mixing time by 15 seconds for each additional 0.75 cu. m.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 FORMWORK PLACEMENT

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 3 mm for smooth-formed finished surfaces.
2. Class B, 6 mm for rough-formed finished surfaces and Parking Structures.
3. **[Class C, 12 mm][Class D, 25 mm]** for rough-formed finished surfaces of foundations elements and grade beams.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.4 INSTALL EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, FE/BR door and window embeds, and blast window embeds, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.5 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 10 deg C for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Project Director/COR.

3.6 SHORES AND RESHORES

A. Comply with ACI 318M and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.7 INSTALL VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 150 mm and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

C. Granular Course: Cover vapor retarder with granular fill moisten, and compact with mechanical equipment to elevation tolerances of plus 0 mm or minus 20 mm.

3.8 INSTALL STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.9 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Project Director/COR.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 40 mm into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to radius of 3 mm. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 3 mm wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 12 mm or more than 25 mm below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.10 INSTALL WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Install factory fabricated corners, intersections, and directional changes. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.11 CONCRETE PLACEMENT, GENERAL

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

1. Notify the Project Director/COR and testing and inspection agencies at least 1 week prior to commencement of concrete placement.
2. Unless approved by the Project Director/COR in writing, project-site additions of water to concrete prior to or during placement is prohibited. Batch water withheld can be added on site as long as total water does not exceed the amount indicated on the concrete mixture design. Exceeding the mixture w/cm ratio is cause for rejection.
3. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause cold joints or planes of weakness.

    a. If section cannot be placed continuously, provide construction joints as indicated in Thermal Control Plan or structural drawings, as applicable.
    b. Deposit concrete to avoid segregation.
    c. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
    d. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

4. Do not use vibrators to transport concrete inside forms.
5. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 150 mm into preceding layer.
6. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
7. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

B. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners. Use immersion-type vibrators with spacing of vibrator insertions not exceeding 1½ times the vibrator's radius of influence within the concrete being consolidated.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

C. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 5 deg C for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

D. Hot-Weather Placement: Comply with ACI 301, 305.1, and as follows:

1. Except as otherwise specified, comply with provisions of ACI 301 and ACI 305.1. In addition, when outdoor shade temperature exceeds 38 deg C, do not mix concrete; when outdoor shade temperature exceeds 26 deg C, comply with the following:
2. Handling: Prevent premature stiffening of fresh mix and reduce evaporation. Mix, transport, place, and consolidate concrete as rapidly as possible.
3. Placing: Before and during placing, maintain formwork and reinforcement below 90 deg F using protection, cold water spraying, or other effective means. When placed in forms, temperature of concrete shall not exceed temperatures indicated in Thermal Control Plan.
4. Elapsed Delivery Time: Elapsed time between water addition to mix and discharge of concrete at site must not exceed criteria in the following Table 3.11 "Elapsed Delivery Time" unless hydration stabilizer admixture is used. Longer times may be allowed at discretion of the Project Director/COR, provided that trial batching demonstrates adequate working time and performance as demonstrated by slump retention evaluation, if necessary.

TABLE 3.11 – ELAPSED DELIVERY TIME

Concrete Temperature at Time of Discharge (deg. C)	Maximum Elapsed Time (Hours)
< 23	2.00
23 – 32	1.50
> 32	0.75

5. Temperature Control Methods: Select one or more of the following methods of maintaining the specified temperature of the placed concrete:

   a. Use chilled mixing water.
   b. Spray coarse aggregate using cold water.
   c. Use ice as replacement of batch water. If used, ice shall be batched by mass and indicated in concrete batch ticket.
   d. Use liquid nitrogen to cool aggregates before mixing; or cool fresh concrete using liquid nitrogen before placing.

E. Rapid Drying Conditions:

1. During rapid drying conditions, such as combinations of the following, special measures shall be employed to reduce drying from the surface of concrete:

   a. High temperatures of 25 deg C or higher.
   b. Direct sun exposure.
   c. Ambient humidity lower than 65 percent.
   d. Wind speed greater than 16 km/hr.

2. Special measures shall include at least one of the following:

   a. Fogging of screeded and freshly finished concrete. Fogging shall be accomplished with fine spray tip on high pressure power-washer that is directed upward into air over concrete surfaces. Fogging shall be used only to maintain damp concrete surface. It shall not be used to wet concrete surfaces immediately prior to finishing.
   b. Use of evaporation reducers. Use in strict conformance to manufacturer recommendations.
   c. Concrete placement at favorable hours of day when rapid drying conditions no longer exist.

3. Maintain special measures until final curing measures are applied.
4. Plastic shrinkage cracking and/or settlement cracking is cause for rejection.

3.12 MASS CONCRETE PLACEMENT

A. Place mass concrete in conformance with the approved Thermal Control Plan; refer to the Part 1 Article on ACTION SUBMITTALS.

B. Temperature and Temperature Difference Limits:

1. Maximum Temperature Limit: Maximum temperature of concrete within mass concrete placement shall not exceed 70 deg C at any time during the thermal control period.
2. Temperature Difference Limit: Maximum temperature difference limit within mass concrete placement shall not exceed 20 deg C.
3. An alternative temperature difference other than 20 deg C may be used, if analyses are performed in accordance with ACI 207.2R-95 or CIRIA C660. These analyses shall use measured properties of accepted mass concrete mixture, shall not include effects of creep to increase temperature difference limit, and shall show that mass concrete mixture and placement are not at risk for cracking based on the use of alternative temperature difference. Alternative temperature difference shall be based on in-place strength of concrete.
4. Temperature difference limit shall be enforced during entire thermal control period.
5. Concrete Temperature at Time of Placement: Initial temperature of mass concrete, as deposited, shall be no greater than 32 deg C unless lower initial temperature is required by accepted thermal control plan to prevent exceeding stated maximum temperature limit or stated maximum temperature difference limit. In addition, initial temperature of mass concrete, as deposited, shall be no less than 7 deg C. Do not place concrete that contains frozen materials. Protect concrete from freezing until curing and thermal control period are complete.

3.13 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing uniform color and texture. Do not apply cement grout other than that created by rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.14 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch (6 mm) in one direction.
3. Apply scratch finish to surfaces [**to receive concrete floor toppings**] [**to receive mortar setting beds for bonded cementitious floor finishes**] <**Insert locations**>.

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 (ACI A117M) tolerances for conventional concrete.
3. Apply float finish to surfaces [**to receive trowel finish**] [**and**] [**to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo**] <**Insert locations**>.

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.

6. Apply trowel finish to surfaces [**exposed to view**] [**or**] [**to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system**] <**Insert locations**>.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155 (ASTM E1155M), for a randomly trafficked floor surface:

   a. Slabs on Ground:

      1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 3.05-m- (10-ft,) long straightedge resting on two high spots and placed anywhere on the surface does not exceed **[6 mm (1/4 inch)][4.8 mm (3/16 inch)][3 mm (1/8 inch)][3 mm (1/8 inch) and also no more than 1.6 mm (1/16 inch) in 610 mm (2 feet)]**.
      2) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
      3) Specified overall values of flatness, F_F 35; and of levelness, F_L 25; with minimum local values of flatness, F_F 24; and of levelness, F_L 17.
      4) Specified overall values of flatness, F_F 45; and of levelness, F_L 35; with minimum local values of flatness, F_F 30; and of levelness, F_L 24.
      5) Specified Overall Value (SOV): F_F 50 and F_L 25 with minimum local value (MLV): F_F 40 and F_L 17.
      6) Specified Overall Value (SOV): F_F 25 and F_L 20 with minimum local value (MLV): F_F 17 and F_L 15.

   b. Suspended Slabs:

      1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 3.05-m- (10ft.-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed **[6 mm (1/4 inch)][4.8 mm (3/16 inch)][3 mm (1/8 inch)][3 mm (1/8 inch) and also no more than 1.6 mm (1/16 inch) in 610 mm (2 feet)]**.
      2) Specified overall values of flatness, F_F 25; and of levelness, F_L 20; with minimum local values of flatness, F_F 17; and of levelness, F_L 15.
      3) Specified overall values of flatness, F_F 35; and of levelness, F_L 20; with minimum local values of flatness, F_F 24; and of levelness, F_L 15.
      4) Specified overall values of flatness, F_F 45; and of levelness, F_L 35; with minimum local values of flatness, F_F 30; and of levelness, F_L 24.

E. Trowel and Fine-Broom Finish: Apply first trowel finish to surfaces [**indicated on Drawings**][**where ceramic or quarry tile is to be installed by either thickset or thinnest method**]. While concrete is still plastic, slightly scarify surface with fine broom perpendicular to main traffic route.

1. Coordinate required final finish with the Architect of Record through the OBO Design Manager before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with the Architect of Record through the OBO Design Manager before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive [**aggregate**][**aluminum granule**] finish to concrete stair treads, platforms, ramps as indicated on Drawings.

1. Apply in accordance with manufacturer's written instructions and as follows:

a. Uniformly spread [**12 kg/10 sq. m (25 lb/100 sq. ft.)**] <**Insert rate**> of dampened slip-resistive [**aggregate**][**aluminum granules**] over surface in one or two applications.
b. Tamp aggregate flush with surface, but do not force below surface.
c. After broadcasting and tamping, apply float finish.
d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive [**aggregate**][**aluminum granules**].

H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of [**49 kg/10 sq. m (100 lb/100 sq. ft.)**] <**Insert rate**> unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader and embed by power floating.
3. Follow power floating with second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
4. After final floating, apply a trowel finish.
5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.15 INSTALL MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as indicated on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.16 CONCRETE CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 1 kg/sq. m x hour (0.2 lb/sq. ft. x hour) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 300 mm lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 300 mm, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.17 TOLERANCES

A. Conform to ACI 117 (ACI 117M).

3.18 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than [**three**][**seven**][**14**][**28**] days' old.
   3. Apply liquid until surface is saturated, scrubbing into surface until gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in similar manner if surface is rough or porous.

B. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.

   1. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match approved mockup.
   2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
   3. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
   4. Control and dispose of waste products produced by grinding and polishing operations.
   5. Neutralize and clean polished floor surfaces.

C. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.19 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month, except for warehouse six month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 50 mm deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.20 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

3.21 FIELD QUALITY CONTROL REQUIREMENTS

A. Independent Quality Assurance Inspector shall perform testing and inspection tasks and submit written reports in accordance with Part 3 Article FIELD QUALITY CONTROL REPORTING to Project Director/COR.

1. Independent Quality Assurance Inspector shall be responsible for providing curing container for concrete specimens on site and verifying that specimens are cured in accordance with ASTM C31.
2. Independent Quality Assurance Inspector shall immediately report to Project Director/COR, Contractor, and Concrete Contractor, and Concrete Supplier any failure of Work to comply with Contract Documents.
3. Independent Quality Assurance Inspector shall report results of tests and inspections, in writing, to Project Director/COR, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

a. Test reports shall include reporting requirements of ASTM C31, C143, C231, C138, C1064, ASTM C39, and ACI 301, including the following as applicable to each test and inspection:

1) Project name.
2) Name of testing agency.
3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
4) Name of concrete manufacturer.
5) Date and time of inspection, sampling, and field testing.
6) Date and time of concrete placement.
7) Location in Work of concrete represented by samples.

8) Date and time sample was obtained.
9) Truck and batch ticket numbers.
10) Specified compressive strength at 28 days.
11) Concrete mixture designation, proportions, and materials.
12) Field test results, slump, plastic air, density and temperature.
13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
14) Type of fracture and compressive break strengths at seven days and 28 days.

B. Batch Tickets: For each load delivered, submit copies of batch delivery ticket to testing agency, indicating quantity of batched materials, mixture identification, admixtures dosages, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site. Material batch weights shall be within tolerance of ASTM C94. Tolerance for water-to-cementitious ratio shall be within -0.03/+0.00. Ready-mix concrete trucks outside of tolerances shall be rejected.

C. Concrete Tests: Sampling of fresh concrete shall be conducted in accordance with ASTM C 172 and be performed in accordance with the following requirements:

1. Testing Frequency: Unless otherwise specified, obtain one sample for each day's pour of each concrete mixture exceeding 4 cubic meters., but less than 20 cubic meters., plus one set for each additional 40 cubic meters or fraction thereof.

   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143:

   a. One test at point of placement for first truck on each placement day.
   b. Perform additional tests when concrete consistency appears to change or every 20 cubic meters.

3. Slump Flow: ASTM C1161:

   a. One test at point of placement for first truck on each placement day.
   b. Perform additional tests when concrete consistency appears to change or every 20 cubic meters.

4. Density: ASTM C138.

   a. ASTM C138 shall be performed at same frequency as specimen fabrication.

5. Air Content: ASTM C231 pressure method for normal-weight concrete.

   a. ASTM C231 testing shall be performed at same frequency as specimen fabrication.

6. Concrete Temperature: ASTM C1064:

a. One test hourly when air temperature is 5 deg C and below or 26 deg C and above, and one test for each concrete sample.

7. Compression Test Specimens: ASTM C31:

a. Sample concrete in accordance with ASTM C172 from the first truck of concrete and every 40 cubic meters of concrete, subsequently.
b. Cast and laboratory cure twelve 100 by 200 mm cylinder specimens for each concrete sample.
c. Cast, initial cure, and field cure nine 100 by 200 mm cylinder specimens for each concrete sample.

8. Compressive-Strength Tests: ASTM C39.

a. Test one set of three laboratory-cured specimens at 3, 7, 28 and 56 days of age.
b. A compressive-strength test shall be the average compressive strength from a set of three specimens obtained from same composite sample and tested at age indicated.
c. Test one set of three field-cured specimens at 3, 7 and 28 days of age.

9. Strength of each concrete mixture is satisfactory if every average of any three consecutive compressive-strength tests performed on laboratory-cured specimens equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 3 MPa.
10. Compressive strength of field-cure specimens shall only be used to determine a structural member is capable of being put in service, determine adequacy of curing and protection of concrete in the structure, or form or shoring removal time requirements.
11. Record temperature of placements by using temperature monitoring system. The Contractor and Project Director/COR shall be notified immediately if temperature of placement appears to exceed maximum temperature limit.
12. Additional Tests:

a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Project Director/COR.
b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by the Project Director/COR.

1) Acceptance criteria for concrete strength shall be in accordance with ACI 301, Section 1.6.6.

13. Additional testing and inspecting, at the Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.22 FIELD QUALITY CONTROL REPORTING

A. Daily Inspection Reports: Independent Quality Assurance Inspector shall prepare daily inspection reports for activities, including base preparation, formwork preparation, reinforcement installation, concrete placement, and temperature control activities. Submit sample forms and describe the procedure used to organize, archive, and retrieve inspection records in the Quality Program submittal.

B. Sampling Reports: Maintain concrete placement log as electronic spreadsheet or database identifying each placement date, placement location, volume of concrete, batch ticket numbers, lot identification code, fresh concrete properties, compressive strength results, transport properties, inspection comments, and acceptance status. Submit log to the Project Director/COR weekly. Submit copies of supporting documents for any placement requested by the Project Director/COE immediately upon request.

C. Quality Control Documentation: Prepare, maintain, and report separate quality control charts illustrating slump, temperature, air content, compressive strength test results, and other required testing results for each lot of each concrete mixture used on the project.

D. Testing and Inspecting: Independent Quality Assurance Inspector shall perform tests and inspections, and to submit test and inspection reports.

E. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

F. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 50 cu. m or fraction thereof of each concrete mixture placed each day.

   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 5 deg C and below and when 27 deg C and above, and one test for each composite sample.
5. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of three field-cured specimens at 7 days and one set of three specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

3.23 CAST-IN-PLACE CONCRETE ACCEPTANCE

A. Before the Government accepts the structure and final payment is made, inspect the structure for cracks, damage, and substandard concrete placements that may adversely affect the service life and performance of the structure. Submit report documenting these defects that includes recommendations for repair, removal, and/or remediation, which will be reviewed by OBO's Subject Matter Expert in concrete materials and submitted to the Project Director/COR for approval before any corrective work is allowed.

B. Contractor Qualifications: Unless otherwise approved by Project Director/COR, repair and rehabilitation of concrete shall be conducted by an experienced concrete repair contractor with track record of performance 5 years or more.

C. Concrete Repair Plan:

1. A Concrete Repair Plan shall be developed by Contractor describing the proposed methods, materials, QA/QC measures, and other information required by the Non-Conformance Report, see Part 3 Article NON-CONFORMANCE REPORT RESOLUTION. The Concrete Repair Plan shall include, at a minimum, the following:

    a. A clear description of the location of the repair area.
    b. Identification of personnel involved, including subcontractors.
    c. Drawings of the repair, including reinforcing steel splices – if any.
    d. Proposed materials to be used in repair.
    e. Description of repair procedure, see Part 3 Article REPAIR OF CONCRETE.
    f. Datasheets of repair materials if prebagged products are used.
    g. Quality Assurance/Quality Control plan to be executed during repair.
    h. Measures to verify performance of the repair after execution.

D. The Concrete Repair Plan shall be submitted to the Project Director/COR for approval.

E. Base the acceptance of concrete strengths on averages of results from three consecutive compressive strength tests. When the averages of three consecutive compressive strength test results are between 1.0 and 1.2 times f'cr, and no individual strength test falls below f'cr by more than 3.5 MPa, the strength of the concrete is satisfactory.

F. When any of the average of three consecutive compressive strength test results is less than f'cr or an individual strength test is lower by more than 3.5 MPa, additional testing will be required as follows:

1. Nondestructive Testing: Impact hammer, ultrasonic pulse velocity, or other nondestructive device may be permitted by Project Director/COR but will not be used as sole basis for approval or rejection of concrete.
2. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Project Director/COR. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Project Director/COR.
3. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
4. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

G. Measure floor and slab flatness and levelness according to ASTM E 1155/ E 1155M within 48 hours of finishing.

H. Quality Control Testing of Reinforcing Steel: Test reinforcing steel as required. Approved independent testing labs are those labs accredited by AASHTO or the International Accreditation Services, Inc. (IAS), or labs at prequalified reinforcing steel mills, or labs at approved AASHTO State Department of Transportation labs. See Attachments B and C.

3.24 CAST-IN-PLACE CONCRETE NON-CONFORMANCE RESOLUTION

A. A non-conformance report shall be documented when any of the following observations, but not limited to, of in-place concrete have been made:

1. Compressive strength results at specified age below the design compressive strength (f'c).
2. Compressive strength results at specified age in excess of 30 percent of design compressive strength (f'c) or approved concrete mixture strength (f'cr) based on concrete submittal data.
3. Presence of voids, honeycombing, cold joints, cracking, surface defects including color and texture irregularities, spalls, air bubbles, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning or other constructability issues during the first 14 days after placement.
4. Exceedance in specified maximum temperature or maximum temperature difference during the period of thermal control.

5. Concrete delivery records that indicate excessive time between mixing and placement and/or excessive water was added to mixture during delivery and placement.

B. When any of the above are observed, a Non-Conformance Report shall document the following:

1. Identify exact location of non-conforming concrete as placed and immediately notify the Contracting Officer and Project Director/COR. Any indicator alone is sufficient reason for the Project Director/COR to request additional sampling and testing to quantify concrete properties. If justified, extract cores for testing, and investigate cause for non-conformance. The investigation may include statistical analysis of test data collected to date; impact of non-conforming material on the structure strength and/or service life; and recommendations for concrete production process improvements, mitigation, or remediation, as appropriate.

C. Investigations into non-conforming materials shall be conducted at no additional cost to the Government. Make written recommendations to adequately mitigate or remediate non-conforming material. The Project Director/COR and Contracting Officer may accept, accept with reduced payment, require litigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

D. Removal and Replacement: Structural concrete members shall be removed and replaced by the Contractor at Contractor's expense when any of the following conditions apply:

1. Cracking, honeycombing, or surface defects are present in a third of volume of in-place concrete or greater.
2. Cracks with width greater than 1.25 mm have been identified. Cracks with width of 1.25 mm or greater observed in structural members carrying structural loads shall be immediately reshored and reported to Project Director/COR.
3. Crack injection procedures have shown incomplete crack filling. Extract a core over a repaired crack and visually determine if at least 80 percent of the crack volume has been filled.

3.25 REPAIR OF CONCRETE

A. General: Refer also to the Part 1 Article on REPAIR SUBMITTALS, and to the Part 2 Article on REPAIR MATERIALS.

B. Any repair activities deemed necessary by Non-Compliance Reports shall consist of:

1. Removing deteriorated concrete as shown and described on the Concrete Repair Plan, including saw cutting perimeter of repair area.
2. Preparing surface of concrete for repair, including abrasive cleaning, cleaning of existing reinforcement, and applying bonding agent to surface.
3. Supplying materials and mixing and placing of concrete repair mortar or concrete as shown and described on the Drawings including vibrating, finishing, and curing.
4. Supplying, fabricating, constructing, maintaining, and removing temporary works, including falsework and formwork.
5. Environmental protection (when applicable).

6. The quality control (QC) testing of all materials.

C. Types of repairs:

1. Concrete repairs will be classified as follows:

a. Partial Depth Repair – Type A:

1) Partial Depth Repair - Type A repair is defined as removal of unsound concrete to a depth not greater than outermost surface of existing reinforcing steel. The Contractor shall remove all unsound concrete from areas as determined by approved repair submittal until sound concrete substrate is exposed.

b. Partial Depth Repair – Type B:

1) Partial Depth Repair - Type B is defined as removal of unsound concrete to depth a minimum of 25 mm beyond existing outer mat of reinforcing steel. For substructure, wall or mass concrete repairs maximum depth shall be 50 mm beyond existing outer mat of reinforcing steel or as directed by approved repair submittal. For slab repairs maximum depth shall be mid depth of slab.

c. Full Depth Repair:

1) Where unsound concrete extends beyond mid depth of concrete member as determined by Condition Assessment Report, the Contractor shall continue to remove all further concrete within repair area to full depth of the member. All existing reinforcing steel shall be re-tied and chaired as necessary. Repair areas shall be neatly formed to restore original geometry of concrete member. Forms shall not be suspended from existing reinforcing steel. Shoring of other concrete members shall be performed to assure safety and structural integrity of non-repaired members.
2) The Contractor shall supply, and place additional reinforcing steel as directed by approved repair submittal when existing reinforcing steel has been removed. Reinforcing steel shall be of same type and size as existing and spliced with minimum lap length of 30 bar diameters. Exposed reinforcing steel shall be sandblasted clean and maintained to near white condition. The Contractor shall roughen all areas of existing sound concrete substrate to 6 mm amplitude using methods described in approved repair submittal.
3) All resulting material and by-products from demolition operations shall be collected, loaded, hauled, and disposed of by the Contractor at an approved waste disposal facility.

D. References: All reference standards and related specifications shall be current issue or the latest revision at the date application.

1. ACI 117, Standard Tolerances for Concrete Construction and Materials
2. ACI 562, Code for Repair of Concrete Structures
3. ACI 563, Specifications for Concrete Repair

4. ICRI No. 120, Guide and Recommendations for Safety.
5. ICRI No. 210, Guide to Verifying Field Performance of Epoxy-Injection
6. ICRI No. 210.4, Guide to Non-Destructive Methods

E. Surface Preparation:

1. Prior to any concrete repairs, the Contractor shall remove all dust, dirt, water and debris from surface of concrete in a manner that will not result in material being deposited into repair area or other portions of the structure outside of repair.
2. The Contractor shall supply and erect appropriate protection barriers/shrouding or other approved means as required on the structure completely contain all loose or flying debris from surface removal preparations. The means of containment shall be subject to the approval of the Project Director/COR with input from the Project Engineer. No debris shall fall into areas below repair area when work is performed at higher elevations.

F. Concrete Removal:

1. All areas of unsound concrete to be repaired will be approved by Project Director/COR once the Contractor has cleaned existing surface as indicated above. The Contractor shall saw cut outer perimeter of repair areas 25 mm deep or as directed by approved submittal. Feathered edges are not acceptable. The Contractor shall take care to ensure that existing reinforcing steel or prestressing strands (if applicable) are not damaged during saw cutting. Any damage caused by the Contractor to any portion of the structure not intended for repair shall be repaired by the Contractor, at the Contractor's expense, to the satisfaction of the Project Director/COR with input from the Project Engineer.
2. The Contractor shall remove all areas of unsound concrete by chipping, pneumatic or other approved methods. Only chipping hammers of 15 kg class or less shall be used, and operated at an angle of 45 degrees or less from the horizontal. The Contractor shall exercise caution and take care not to damage any existing reinforcing steel intended to remain in place.

G. Crack Repair:

1. Prior to final acceptance, document and repair cracks in excess of 0.5 mm. Submit proposed means, methods, and materials to repair cracks to the Contracting Officer for approval. Address the amount of movement expected in crack due to temperature changes and loading.
2. Cracks with a mean width greater than 1 mm shall be inspected by means of non-destructive testing, extraction of cores or other methods approved by the Project Director/COR. Contractor shall bear cost of the condition assessment and submit written repair procedure for review and approval by the Project Director/COR. The repair report shall include a complete assessment of the severity of the cracking, the length, width and depth of cracks from the concrete surface, the proposed means of repair, and verification of testing. Repair procedure, materials and requirements outlined in ACI 563 shall be applicable.

H. Curing:

1. Curing shall be in accordance with the manufacturer's instructions or as otherwise required in this Section.

I. Field Quality Control of Repairs:

1. Concrete repairs mortar that are not placed, cured or performed in accordance with approved concrete repair submittal may be rejected by the Project Director/COR and their decision shall be considered final. The Project Director/COR reserves the right to require immediate removal of any concrete from rejected batches that may have already been placed in the structure.
2. Quality assurance testing shall be carried out by the Contractor (or their Sub-Contractors), and all associated costs shall be paid for by the Contractor.

J. Acceptance of Repair:

1. For all concrete repairs, the repair will be deemed accepted when companion cylinders have attained minimum compressive strength of 95 percent of specified compressive strength of original concrete, and display no evidence of cracking, honeycombing or other workmanship deficiencies. Non-compliant repairs will require a condition assessment and subsequent repair, following the repair procedures in this Section.

END OF SECTION 033000

ATTACHMENT A
CONCRETE DESIGN MIXTURES SUBMITTAL FORM
See Article on SUBMITTALS in this Section

Project: _____
City: _____
General Contractor: _____
Concrete Contractor: _____
Concrete Strength (Class): _____
Use (Describe): _____

Design Mixtures Information (Check One)

Based on Std. Deviation Analysis ☐
Trial Mixture Text Data ☐

Design Characteristics

Density		kg/m^3
Strength		MPa (indicate 28 day or 56 day)
Air		% specified

If trial mixtures are used, the Design Mixtures shall be proportioned to achieve a required average compressive strength f′cr as follows:

- For f'c ≤ 35 MPa use the larger of: f'cr = f'c + 8.3 (MPa)
- For f'c > 35 MPa use the larger of: f'cr = 1.1f'c + 5 (MPa)

MATERIALS	TYPE/ SOURCE	SPECIFIC GRAVITY	MASS (kg)	ABSOLUTE VOL. (m^3)
Cement				
Fly Ash				
Silica Fume				
GGBF Slag				
Other Pozzolans (specify)				
Fine Aggregate				
Course Aggregate				
Water				
Air				
Other				
		Total		m^3

Water/Cementitious Material Ratio (kg water/kg cementitious material) = _____

ADMIXTURES	MANUFACTURER	DOSAGE (metric)
Water Reducer		
Air Entraining Agent		
High Range Water Reducer		
Non-Corrosive Accelerator		
Other		

Slump before HRWR _____ mm
Slump after HRWR _____ mm

Standard Deviation Analysis (from experience records):

# of Test Cylinders Evaluated:	
Standard Deviation:	

Required average compressive strength f'cr, when data is available to establish a standard deviation:

For f'c $\leq$ 35 MPa use the larger of:

- f'cr = f'c + 1.34s (MPa)
- f'cr = f'c + 2.33s-3.5 (MPa)

For f'c > 35 MPa use the larger of:

- f'cr = f'c + 1.34s (MPa)
- f'cr = 0.90f'c + 2.33s (MPa)

Note: Refer to ACI 301 to adjust deviation if total number of tests is less than 30.

Laboratory Test Data

Compressive strength

AGE (DAYS)	MIX #1	MIX #2	MIX #3
7	MPa	MPa	MPa
7	MPa	MPa	MPa
28	MPa	MPa	MPa
28	MPa	MPa	MPa
28 average	MPa	MPa	MPa
56	MPa	MPa	MPa
56	MPa	MPa	MPa
56 average	MPa	MPa	MPa

REQUIRED ATTACHMENTS:

Combined Aggregate Gradation Report	
Standard Deviation Analysis Summary or Trial Mixture Test Data	
Admixture Compatibility Certification Letter	

Note: 8% - 18% aggregate required to be retained on each sieve except the top size and the #100

Submitted by:

Name: _____

Address: _____

_____

Phone #: _____

Main Plant Location: _____

Kilometers to Project: _____

Secondary Plant Location: _____

Kilometers to Project: _____

_____

Date: _____

ATTACHMENT B
PREQUALIFIED REINFORCING STEEL MILLS
See Article on QUALITY ASSURANCE in this Section

The following are prequalified to supply reinforcing steel on OBO projects subject to requirements of specifications and other contract requirements.

STEEL MILL	LOCATION & CONTACT INFO
Arcelor Mittal - Harriman	2404 South Roane Street Harriman, TN 37748 (865) 882-5100 Usa.aracelormittal.com
Arcelor Mittal - Vinton	I-10 And Vinton Road El Paso, TX 79385 (915) 886-2000 Usa.arcelormittal.com
Byer Steel	204 W. North Bend Road Cincinnati, OH 45216 (513) 679-4499 www.byersteelminded.com
CMC Steel - Arizona	11444 E. Germann Rd. Mesa, AZ 85212 (480) 396-7200 www.cmc.com
CMC Steel – South Carolina	310 New State Road Cayce, SC 29033 (800) 637-3227 www.smi-sc.com
CMC Steel - Texas	P.O. Box 911 Seguin, TX 78156-0911 (830) 372-8200 www.smi-texas.com
Cascade Rolling Mill, Inc.	3200 N. Highway 99W P.O. Box 687 McMinnville, OR 97128 (503) 472-4181 www.cascadesteel.com/
EVRAZ- Pueblo	P.O. Box 316 Pueblo, CO 81002 (719) 561-6000 www.evrazna.com
Gerdau – Beaumont	Old Highway 90 P.O. Box 3867 Beaumont, TX 77704 (409) 768-1211 www.gerdau.com/longstreet/
Gerdau – Charlotte	6601 Lakeview Road Charlotte, NC 28269 (704) 596-0361 www.gerdau.com/longstreet/

STEEL MILL	LOCATION & CONTACT INFO
Gerdau – Jackson	801 Gerdau Ameristeel Road Jackson, TN 38305 (731) 424-5600 www.gerdau.com/longstreet/
Gerdau – Jacksonville	Hwy. 217 Yellow Water Road Baldwin, FL 32234 (904) 266-4261 www.gerdau.com/longstreet/
Gerdau – Knoxville	1919 Tennessee Ave N. W. Knoxville, TN 37921-2696 (865) 546-5472 www.gerdau.com/longstreet/
Gerdau – Midlothian	300 Ward Road Midlothian, TX 76065 (800) 527-7979 www.gerdau.com/longstreet/
Gerdau – Rancho Cucamonga	P.O. Box 325 12459-B Arrow Rte. Rancho Cucamonga, CA 91739 (909) 899-0660 www.gerdau.com/longstreet/
Gerdau – Sayreville	North Crossman Road Sayreville, NJ 08872 (732) 721-6600 www.gerdau.com/longstreet/
Gerdau – St. Paul	1678 Red Rock Road St. Paul, MN 55119 (651) 731-5600 www.gerdau.com/longstreet/
Nucor Steel - Auburn	25 Quarry Road PO Box 2008 Auburn, NY 13021 (800) 424-1494 www.nucorbar.com
Nucor Steel - Birmingham	2301 F. L. Shuttlesworth Dr. Birmingham, AL 35234 (866) 862-4796 www.nucorbar.com
Nucor Steel - Connecticut	35 Toelles Road Wallingford, CT 06492 (203) 265-0615 www.nucorbar.com
Nucor Steel - Jackson	3630 Fourth Street Jackson, MS 39232 (800) 723-1623 www.nucorbar.com

STEEL MILL	LOCATION & CONTACT INFO
Nucor Steel - Kankakee	One Nucor Way Bourbonnais, IL 60914 (800) 866-3131 www.nucorbar.com
Nucor Steel - Marion	912 Cheney Avenue Marion, OH 43302 (800) 333-4011 www.nucorbarl.com
Nucor Steel - Seattle	2424 SW Andover Seattle, WA 98106-1100 (800) 677-1012 www.nucorbar.com
Nucor Steel – South Carolina	300 Steel Mill Rd. Darlington, SC 29540 (800) 999-7461 www.nucorbar.com
Nucor Steel - Texas	P.O. Box 126 Jewett, TX 75846 (800) 527-6445 www.nucorbar.com
Nucor Steel – Utah	Nucor Steel - Utah PO Box 100 Plymouth, UT 84330 (800) 453-2886 www.nucorbar.com

ATTACHMENT C
APPROVED INDEPENDENT TESTING LABORATORIES
See Article on QUALITY ASSURANCE in this Section

The following are OBO approved independent testing laboratories for evaluation of reinforcing steel for compliance with ASTM A 615/A 615M and ASTM A 706/A 706M. In addition, laboratories at State Departments of Transportation with AASHTO certification for testing reinforcing steel may be used, and laboratories at OBO prequalified reinforcing steel mills (see Attachment B to this Section) may be used.

STATE	LABORATORY	PHONE/WEB SITE	CONTACT	Accreditation A B
AZ	Western Technologies Phoenix, AZ	(602) 437-3737 www.wt-us.com	Dr. Raphael Tixier r.tixier@wt-us.com	AASHTO
CA	AMEC Los Angeles, CA	(323) 889-5315 www.amec.com	Ian A. Maclean Ian.maclean@amec.com	AASHTO
CA	AMEC San Diego, CA	(858) 278-3600 www.amec.com	Elizabeth A. Newell-Collins Liz.collins@amec.com	AASHTO
CA	Applied Materials & Engineering Oakland, CA	(510) 420-8190 www.appmateng.com	Mr. Mohammed Faiyaz mohammed@appmateng.com	AASHTO
CA	BSK Associates Fresno, CA	(559) 497-2868 www.bskinc.com	Suzie Morgan smorgan@bskinc.com	AASHTO
CA	BTC Labs - Vertical V Ventura, CA	(805) 656-6074 www.nv5.com	Jeff Tawakoli Jeff.tawakoli@nv5.com	AASHTO
CA	C.H.J., Incorporated Colton, CA	(909) 824-7210 www.chjinc.com	Phillip Stephens pstephens@chjinc.com	AASHTO
CA	Caltech Labs, Inc. Brea, CA	(619) 200-2587 www.caltech-labs.com	Horacio Martin Horacio@caltech-labs.com	AASHTO
CA	CGITechnical Services Redding, CA	(530) 244-6277 www.currygroup.com	Patrick Smith ccurry@currygroup.com	AASHTO
CA	Condor Earth Technologies Stockton, CA	(209) 234-0518 www.condorearth.com	Russell Long rlong@condorearth.com	AASHTO
CA	Consolidated Engineering Laboratories North Highlands, CA	(916) 343-1703 www.ce-labs.com	Daniel R. Allopenna dra@ce-labs.com	AASHTO
CA	Consolidated Engineering Laboratories Oakland, CA	(510) 436-7626 www.ce-labs.com	Rick Navarro jp@ce-labs.com	AASHTO IAS
CA	Consolidated Engineering Laboratories Windsor, CA	(707) 838-1115 www.ce-labs.com	Virgil Garner vlg@ce-labs.com	AASHTO
CA	Construction Testing & Engineering Escondido, CA	(760) 746-4955 www.cte-inc.net	Erik Campbell erik@cte-inc.net	AASHTO
CA	Construction Testing Services	(925) 462-5151	Ms. Yate Chhoun	AASHTO

STATE	LABORATORY	PHONE/WEB SITE	CONTACT	Accreditation A B
	Pleasanton, CA	www.cts-1.com	pgreenan@cts-1.com	
CA	Converse Consultants Monrovia, CA	(626) 930-1239 www.converseconsultants.com	Chris Greenleaf monrovialab@converseconsulants.com	AASHTO
CA	DC Inspections Bakersfield, CA	(661) 393-9001 www.dcinspections.com	Jeremy Shirley jshirley@dcinspections.com	AASHTO
CA	Earth Systems Pacific San Luis Obispo, CA	(805) 544-3276 www.earthsystems.com	Mr. Fred J. Potthast fred@earthsys.com	AASHTO
CA	Earth Systems Southern California Palmdale, CA	(661) 948-7538 www.earthsys.com	Mr. Tim Thomson tthomson@earthsys.com	AASHTO
CA	G Force San Diego, CA	(619) 583-6633 www.gforceca.com	Joe Bouknight jbouknight@gforceca.com	AASHTO
CA	Group Delta Consultant Torrance, CA	(310) 320-5100 www.groupdelta.com	Mr. Thomas D. Swantko ericy@groupdelta.com	AASHTO
CA	Inspection Services Berkeley, CA	(415) 243-3265 www.inspectionservices.net	Lorenzo Lawson llawson@inspectionservices.net	AASHTO
CA	John R. Byerly, Inc. Bloomington, CA	(909) 877-1324 www.johnrbyerlyinc.com	Sonny Widjaja sonny@johnrbyerlyinc.com	AASHTO
CA	Kleinfelder, Inc. Hayward, CA	(925) 484-1700 www.kleinfelder.com	Aaron Kidd akid@kleinfelder.com	AASHTO
CA	Kleinfelder West Ontario, CA	(909) 657-1716 www.kleinfelder.com	Mr. Greg Degener Gdegener.@kleinfelder.com	AASHTO
CA	Kleinfelder, Inc. San Diego, CA	(858) 320-2000 www.kleinfelder.com	Mr. Ulysses Panuncialman upanuncialman@kleinfelder.com	AASHTO
CA	Kleinfelder, Inc. Sacramento, CA	(916) 366-1701 www.kleinfelder.com	Mr. Christopher Pollack cpollack@kleinfelder.com	AASHTO
CA	Kleinfelder, Inc. Santa Rosa, CA	(707) 571-1883 www.kleinfelder.com	Mr. Timothy Casey tcasey@kleinfelder.com	AASHTO
CA	Koury Engineering & Testing, Inc. Chino, CA	(909) 606-6111 www.kouryengineering.com	Mr. Chris Loera chrisl@kouryengineering.com	AASHTO
CA	Krazan & Associates Bakersfield, CA	(661) 837-9200 www.krazan.com	Mr. Ryan Privett ryanprivett@krazan.com	AASHTO
CA	Landmark Consultants El Centro, CA	(760) 370-3000 www.landmark-ca.com	Mr. Jeffrey O. Lyon jlyon@landmark-ca.com	AASHTO
CA	Leighton Consulting Irvine, CA	(949) 681-4217 www.leightongroup.com	Mr. Ryan Densmore rdensmore@leightongroup.com	AASHTO
CA	MACTEC Engineering and Consulting San Diego, CA	(858) 278-3600 www.mactec.com	Ms. Elizabeth Newell-Collins lcollins@mactec.com	AASHTO
CA	MatriScope Engineering Laboratories	(916) 375-6700 www.matriscope.com	Steve Lee rtadlock@matriscope.com	AASHTO
CA	Mechanical Rebar Testing Livermore, CA	(925) 960-0312	Jon Garland	

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STATE	LABORATORY	PHONE/WEB SITE	CONTACT	Accreditation A B
CA	Moore Twining Assoc. Fresno, CA	(559) 268-7021 www.mooretwining.com	Mr. Michael Shwiyhat michaels@mooretwining.com	AASHTO
CA	MTGL, Inc. Anaheim, CA	(714) 632-2999 www.mtglinc.com	Mr. Reid Briley rbriley@mtglinc.com	AASHTO
CA	MTGL, Inc. Riverside, CA	(714) 632-2999 www.mtglinc.com	Mr. Michael J. Landon mlandon@mtglinc.com	AASHTO
CA	MTGL, Inc. San Diego, CA	(858) 537-3999 www.mtglinc.com	Mr. John Hutalla jhutalla@mtglinc.com	AASHTO
CA	Ninyo & Moore San Diego, CA	(858) 576-1000 www.ninyoandmoore.com	Darin Vojtaskovic dvojtaskovic@ninyoandmoore.com	AASHTO
CA	River City Testing Riverside, CA	(951) 697-0800 www.rivercitytesting.biz	Mr. Lance McCoy lance.mccoy@rivercitytesting.biz	AASHTO
CA	RMA Group Rancho Cucamonga, CA	(909) 989-1751 www.rmacompanies.com	Mr. Steve Pitzer spitzer@rmacompanies.com	AASHTO
CA	RMA Group San Diego, CA	(909) 989-1751 www.macompanies.com	Mr. Steve Pitzer spitzer@rmacompanies.com	AASHTO
CA	Sierra Testing Labs El Dorado Hills, CA	(916) 939-3460 sierratestinglaboratories.com	Mr. William Maynard tturner@sierratestinglaboratories.com	AASHTO
CA	Signet Testing Laboratories, Inc. Hayward, CA	(510) 887-8484 www.signettestinglabs.com	Mr. Gabriel Hernandez greg.ruf@urs.com	AASHTO
CA	Signet Testing Laboratories Anaheim, CA	(714) 399-1500 www.urscorp.com	Mr. David J. Ryan david_ryan@urscorp.com	AASHTO
CA	Signet Testing Labs. Sacramento, CA	(916) 568-5858 www.urscorp.com	Mr. Eric Stoermer eric_stoermer@urscorp.com	AASHTO
CA	Smith-Emery Company San Francisco, CA	(415) 642-7339 www.smithemerysf.com	Mr. Pat Morrison pmorrison@smithemerysf.com	AASHTO
CA	Smith-Emery Labs. Los Angeles, CA	(213) 745-5333 www.smithemerylabs.com	Janeth Quintero ppatel@smithemerylabs.com	AASHTO IAS
CA	Southern California Soil & Testing San Diego, CA	(619) 280-4321 www.scst.com	Mr. Ron Baudour rbaudour@scst.com	AASHTO
CA	Soils Engineering Bakersfield, VA	(661) 831-5100 www.soilsengineering.com	Julian Williamson Julian@soilsengineering.com	IAS
CA	Southwest Inspection & Testing La Habra, CA	(562) 941-2990 www.southwesttesting.com	Renan R. Cruz renanc@southwesttesting.com	IAS
CA	Specialized Testing Santa Fe Springs, CA	(562) 903-0032	Martin Mejia	IAS
CA	Summit Associates Oakland, CA	(510) 614-1044 www.summitcm.com	Mr. Mark Alexander mark.alexander@summitcm.com	AASHTO
CA	Technicon Engineering Services Fresno, CA	(559) 276-9311 www.technicon.net	Mr. Brian Hall brianh@technicon.net	AASHTO

STATE	LABORATORY	PHONE/WEB SITE	CONTACT	Accreditation A B
CA	Testing Engineers, Inc. San Leandro, CA	(510) 835-3142 www.testing-engineers.com	Mr. Terry L. Egland terry@testing-engineers.com	AASHTO
CA	Testing Services – Vertical V San Diego, CA	(619) 715-5800 www.nv5.com	Mr. Carlos E. Acero carlos.acero@nv5.com	AASHTO
CA	Twining, Inc. Long Beach, CA	(562) 426-3355 www.twininglabs.com	Mr. Andrew Tan info@twininglabs.com	AASHTO
CA	United Inspection and Testing, Inc. Moreno Valley, CA	(951) 697-4777 www.uit-inc.us	Mr. Zafar hmed steve@uit-inc.us	AASHTO
CA	Wallace-Kuhl & Associates West Sacramento, CA	(916) 372-4100 www.wallace-kuhl.com	Mr. David A. Redford dredford@wallace-kuhl.com	AASHTO
CA	Wallace-Kuhl & Assoc. Stockton, CA	(209) 234-7722 www.wallace-kuhl.com	Mr. David Hunn dhunn@wallace-kuhl.com	AASHTO
FL	AMEC Jacksonville, FL	(904) 391-3759 www.amec.com	Mr. Mark Coleman mark.coleman@amec.com	AASHTO
GA	Engineering Systems Norcross, GA	(678) 990-3280 esi-website.com	Reed Pruitt rapruitt@esi-atl.com	AASHTO
GA	Testing, Engineering & Consulting Services Lawrenceville, GA	(770) 995-8000 www.tecservices.com	Mr. Shawn P. McCormick Shawn.McCormick@tecsvcs.com	AASHTO
ID	Strata Boise, ID	(208) 376-8200 www.stratageotech.com	Christopher Kaetzel ckaetzel@stratageotech.com	AASHTO
IL	CTL Group Skokie, IL	(847) 972-3058 www.ctlgroup.com	Mr. Gary Gan ggan@ctlgroup.com	AASHTO IAS
IL	Wiss, Janney, Elstner Northbrook, IL	(847) 272-7400 www.wje.com	Mr. Todd Nelson tnelson@wje.com	IAS
MD	Froehling & Robertson Jessup, MD	(443) 733-1011 www.fandr.com	Victoria Bremseth vbremseth@fandr.com	AASHTO
NE	Olsson Associates La Vista, NE	(402) 827-7220 www.oaconsulting.com	Caerhl Irey cirey@olssonassociates.com	AASHTO
NV	Aztech Inspections and Testing Las Vegas, NV	(702) 247-7645 www.aztechnispections.com	Mr. Dieu Phan dphan@aztechinspections.com	AASHTO
NV	Mesquite Material Test. Las Vegas, NV	(702) 643-2804 www.mmtnevada.com	Mr. Daniel Billoch m.eaton@mmtnevada.com	AASHTO
SC	F&ME Consultants Columbia, SC	(803) 254-4540 www.fmecol.com	Mr. Jerry Hiers jhiers@fmecol.com	AASHTO
SC	Shaw Power Group Jenkinsville, SC	(803) 345-8518	Steven Davis Jason.ashe@shawgrp.com	AASHTO
SC	Soil Consultants, Inc. Charleston, SC	(843) 723-4539 www.soilconsultantsinc.com	Mr. Wm. Kenneth Johnson kennyj@soilconsultantsinc.com	AASHTO
SC	Terracon Consultant North Charleston, SC	(843) 884-1234 www.terracon.com	Jason Hatch jehatch@terracon.com	AASHTO
SC	URS Corporation Aiken, SC	(803) 557-4761 www.urs.com	Michael DiTullio Michael.citullio@urs.com	AASHTO

STATE	LABORATORY	PHONE/WEB SITE	CONTACT	Accreditation [A] [B]
VA	Froehling & Robertson Chesapeake, VA	(757) 436-1111 www.fandr.com	Marvin L. Farmer mfarmer@fandr.com	AASHTO
WA	Kleinfelder, Inc. Redmond, WA	(425) 636-7900 www.kleinfelder.com	Mr. Brad Kochanski bkochanski@kleinfelder.com	AASHTO IAS
Puerto Rico	Jaca & Sierra Testing Laboratories Trujillo Alto, Puerto Rico	(787) 761-2570 www.jacasierra.com	Jose Garcia jgarcia@jacasierra.com	AASHTO
Qatar	Arab Center for Engineering Studies Doha, Qatar	+974 44870141 www.aces-int.com	Abdulrahim Sukik	IAS
Qatar	Qatar Engineering Laboratories Doha, Qatar	+974 44515403	Narayanan Sabu qel@qel.com.qa	IAS
Qatar	Qatar Industrial Laboratories Doha, Qatar	+974 55527497	Syed Mehmood	IAS

[A] Before engaging any lab listed in Attachment C, verify current certification from appropriate certification organization.

[B] Accrediting Organization Contact Information:

AASHTO Material Reference Laboratory (AMRL): Frederick, MD 21704; (240) 436-4900; www.amrl.net

International Accreditation Services, Inc. (IAS): Whittier, CA 90601; (562) 699-0541; www.iasonline.org

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ATTACHMENT D
ACI INTERNATIONAL PARTNER ASSOCIATIONS
See Article on QUALITY ASSURANCE in this Section

The following organizations are ACI International Partner Associations. Certification and training programs from ACI International Partner Associations may be utilized as appropriate to satisfy certification and qualifications requirements for Installers and Testing Agencies identified in Article on QUALITY ASSURANCE, with approval from Project Director/COR.

ACI INTERNATIONAL PARTNER	INTERNET SITE
Asian Concrete Federation (ACF)	https://www.asianconcretefederation.org
Associacao Nacional de Pisos e Revestimentos de Alto Desempenho (ANAPRE) - Brazil	http://www.anapre.org.br/
Austrian Society for Concrete and Construction Technology (ASCCT)	https://bautechnik.pro
Cement Concrete & Aggregates Australia (CCAA)	https://www.ccaa.com.au
China Concrete & Cement Products Association (CCPA)	http://www.ccpa.com.cn/
Colombian Association of Earthquake Engineering (AIS)	https://procem.co/
Concrete Institute of Australia (CIA)	www.concreteinstitute.com.au
Concrete Society of Southern Africa (CSSA)	https://www.cemcon-sa.org.za
Czech Concrete Society (CCS)	https://www.cbsbeton.eu/en/
Hong Kong Concrete Institute (HKCI)	www.hongkongci.org
Iberoamerican Federation of Ready Mixed Concrete (FIHP)	http://www.hormigonfihp.org/
Instituto Brasilerio do Concreto (IBRACON)	www.ibracon.org.br
Instituto Chileno del Cemento y del Hormigon (ICH)	www.ich.cl
Instituto Mexicano del Cemento y del Concreto (IMCYC)	www.imcyc.com
Japan Concrete Institute (JCI)	www.jci-net.or.jp
Korea Concrete Institute (KCI)	www.kci.or.kr

ACI INTERNATIONAL PARTNER	INTERNET SITE
New Zealand Concrete Society (NZCS)	www.concretesociety.org.nz
Norwegian Concrete Association (NCA)	www.betong.net
Polish Academy of Sciences (KILW)	www.pan.pl
RILEM	www.rilem.net
Shanghai Concrete Industry Association (SCIA)	-
Shanghai Research Institute of Building Sciences (SRIBS)	-
Swedish Concrete Association (SCA)	www.betong.se
Taiwan Concrete Institute (TCI)	-
The Concrete Society (UK)	www.concrete.org.uk
Vietnam Concrete Association (VCA)	www.ibst.vn

ATTACHMENT E
QUALITY ASSURANCE PLAN EXAMPLE

The objective of the concrete quality control program is for the Contractor to outline the procedures that will be used to construct a structure that will obtain the design durability, including development of a concrete quality control program. The Contractor must develop and submit for approval the concrete quality control program in accordance with ACI PRC-121 and as specified herein. The plan must include approved laboratories. The Contractor must provide direct oversight for the concrete quality control program. If concrete cylinders tested during production indicate inadequate strength, excessive ion-transport properties, or inadequate mixing, then the Contracting Officer may require the Contractor to extract concrete core samples from the hardened concrete for analysis at the Contractor's expense to assure that the quality of the concrete as placed and cured will satisfy the defined design durability. The concrete quality control plan must define non-conforming materials per paragraph Non-Conforming Materials and document the procedures for handling the non-conformity. Items in paragraph CAST-IN-PLACE CONCRETE NON-CONFORMANCE RESOLUTION must be addressed.

Develop and submit for approval a concrete quality control program in accordance with ACI PRC-121. Maintain a copy of ACI MNL-15 and CRSI 10MSP at the project site.

X.X.1 Quality Control Personnel:

The Contractor must submit for approval an organizational chart defining the quality control hierarchy, the responsibilities of the various positions, including the names and qualifications of the individuals in those positions.

Submit American Concrete Institute certification for the following:

a. Contractor Quality Control (CQC) personnel responsible for inspection of concrete operations.
b. Lead foreman or journeyman of the concrete placing, finishing, and curing crews.
c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.
d. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.
e. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of the specific deleterious processes and tests identified in this specification. Resume must detail the education, training and experience related to the project-specific test methods and deleterious materials and must be submitted at least 20 days before petrographic and deleterious materials examination is to commence.

X.X.1.1 Quality Control Manager Qualifications:

The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least three projects with large water control features, unless approved by the Contracting Officer. Evidence of proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

X.X.1.2 Field Testing Technician and Testing Agency:

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI MNL-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI MNL-2.
b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.
c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077, CCRL or ISO 17025.

X.X.2 Laboratory Qualifications for Concrete Qualification Testing:

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected. Unless otherwise specified herein, the laboratory must be equipped and experienced in the performance of ASTM C1556 and ASTM C1202.

X.X.3 Laboratory Accreditation:

Laboratory and testing facility services must be provided by and at the expense of the Contractor. The laboratories and testing facilities performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified.

a. Aggregate Testing and Mix Proportioning: Perform by an accredited laboratory and under the direction of a currently licensed civil engineer in a U.S. state or territory, who must sign and seal all reports and designs.
b. Acceptance Testing: Furnish materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.
c. Contractor Quality Control: Sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

X.X.4 Concrete Batch Plant Certification:

Concrete batch plants, either permanent or set-up for this project must be certified by NRMCA CPMB 100 per the Plant and Truck Certification Program.

X.X.4.1 Concrete Delivery Vehicle:

Concrete delivery vehicles must be certified by NRMCA CPMB 100 per the Plant and Truck Certification Program.

X.X.4.2 Concrete Batch Plant Operator:

Concrete Batch Plant Operator: Have a current National Ready Mixed Concrete Association (NRMCA) Plant Manager Certification at the Plant Manager level.

SECTION 055005 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel framing and supports for ceiling-hung toilet compartments.
2. Steel framing and supports for operable partitions.
3. Steel framing and supports for overhead doors and grilles.
4. Steel framing and supports for countertops.
5. Steel tube reinforcement for low partitions.
6. Steel framing and supports for mechanical and electrical equipment.
7. Support framing for stone cladding or architectural precast concrete.
8. Steel framing and supports for applications where framing and supports are not specified in other Sections.
9. Elevator machine beams, hoist beams, and divider beams.
10. Steel shapes for supporting elevator door sills.
11. Shelf angles.
12. Metal ladders.
13. Metal ships' ladders.
14. Elevator pit sump covers.
15. Anti-ram metal bollards, and other anti-ram metal framing and reinforcement.
16. General metal bollards (i.e., not used for anti-ram purposes).
17. Miscellaneous steels plates and related framing for FE (Forced Entry) and BR (Ballistic Resistant) security assemblies
18. Miscellaneous steel trim.
19. Loose bearing and leveling plates for applications where not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.

2. [Division 04 Section on unit masonry for installing loose lintels, anchor bolts, and other items built into unit masonry.]
3. [Division 05 Section on structural steel framing.]
4. Division 08 Sections for steel embeds related to security doors, windows, and louvers.
5. Division 09 Sections on general painting.
6. Section 099605 “High-Performance Coatings.”
7. Section 323120 “Decorative Metal Fences” for perimeter security fences and general control fences.
8. Section 323305 “Site Furnishings” for metal site furnishings.
9. Division 32 Sections for perimeter security gates and associated fencing, rising bollard barricades, and other perimeter security assemblies.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Professional Certification: Provide Shop Drawings and engineering calculations prepared and sealed by Registered Professional Engineer, licensed in accordance with requirements of the OBO Building Code, for fabrications required to comply with structural requirements.

B. Product Data: Manufacturer’s specifications and installation instructions for products used in miscellaneous metal fabrications, including paint products and grout.

C. [Sustainable Design Submittals:

1. Product Data: For recycled content, indicating post-consumer and pre-consumer recycled content and cost.]

D. Shop Drawings: Show fabrication and installation details for all fabrications. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

E. Delegated-Design Submittal: Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Calculations: Submit engineering calculations for fabrications required to comply with structural requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Design Modifications: Submit for review proposed substitution requests in accordance with Division 01.

B. Qualification Data: For professional engineer.

C. Certificates:

1. Submit certification that materials receiving polyurethane coating system have received compatible surface preparation and priming.
2. Submit certification that steel to be galvanized contains elements within ranges listed below:

a. Carbon: Less than 0.25 percent.
b. Phosphorus: Less than 0.05 percent.
c. Manganese: Less than 1.35 percent.
d. Silicon: Within range of 0 to 0.04 percent or 0.15 to 0.25 percent.

3. [Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.]
4. Welding certificates.

5. [Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.]

D. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Designer/Engineer Qualifications: Design elements required to meet structural requirements under direct supervision of a Registered Professional Engineer, licensed in accordance with requirements of the OBO Building Code.

B. Fabricator and Installer Qualifications: Not less than 5 years documented, successful experience with work comparable to Work of this Project.

C. Welding Standards:

1. Comply with applicable provisions of AWS D1.1 “Structural Welding Code--Steel,” AWS D1.2 “Structural Welding Code--Aluminum,” and AWS D1.3 “Structural Welding Code--Sheet Steel.”
2. Welder qualifications: AWS certified for type of welding required.
3. Finish joints in accordance with National Ornamental & Miscellaneous Metals Association (NOMMA) Guideline 1:

   a. Finish 1: No evidence of a welded joint.
   b. Finish 2: Completely sanded joint, some undercutting and pinholes acceptable.
   c. Finish 3: Partially dressed weld with splatter removed.
   d. Finish 4: Good quality, uniform undressed weld with minimal spatter.

D. Galvanizing:

1. Coating Applicator: Company specializing in hot dip galvanizing after fabrication approved by manufacturer or fabricator.
2. Hot-Dip Galvanizing Fabrication Practices: Conform to requirements of ASTM A123, A143, A384 and A385 unless otherwise specified.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication. Verify conditions in existing buildings affecting the metal fabrications prior to the submission of shop drawings for review.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. If bolts and nuts become dry or rusty, clean and lubricate before use with lubricants that are compatible with laminated glazing.

C. Do not store materials on structure in a manner that might cause distortion or damage to structural members or supporting structures. Repair or replace damaged materials or structures as directed.

D. Store materials, other than fabricated steel, in weather-tight containers until ready for use in work. Store containers in dry place.

E. Store electrodes in rod ovens and heat in accordance with AWS Code, Section 4.5 prior to use in welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design metal fabrications.

B. Design Requirement:

1. Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished product for use intended.
2. Design and fabricate components to support loads indicated or required to comply with requirements of authorities having jurisdiction over Project.
3. Design modifications:

a. May be proposed by manufacturer to satisfy performance requirements.
b. Must conform to design and specified durability and strength.
c. Must maintain profiles and alignments indicated.

C. Structural Performance:

1. Treads, Platforms, and Gratings: Capable of withstanding uniform load of 5.00 kN/m^2 , and a non-concurrent concentrated load of 1.33 kN acting over an area of 2580 mm^2 applied at any point. These elements shall be capable of withstanding stresses resulting from railing loads in addition to loads specified above.
2. Ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
3. Refer to Structural Drawings and OBO-ICS IBC Chapter 16 for structural performance requirements for elements not listed above.

D. Visual Requirements: For metal fabrications exposed to view, use materials which are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness.

E. Interface with Other Systems:

1. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchors, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which will be embedded in concrete or masonry construction.
2. Coordinate delivery of such items to Project site.
3. Metal fabrications shall be detailed to ensure that no reinforcing steel embedded in concrete substrates are damaged during installation of post-installed anchors, except as explicitly approved by the Structural Engineer of Record.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: **<Insert temperature change, but not less than 67 deg C, ambient; 100 deg C, material surfaces.>**

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. [Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert value> percent.]

C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Steel Sheet:

1. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008 either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.
2. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011 either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.
3. Galvanized Steel Sheet: ASTM A653, G90 coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.

E. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, **[Type 304] [Type 316L]**.

F. Stainless-Steel Bars and Shapes: ASTM A 276, **[Type 304] [Type 316L]**.

G. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D, minimum 0.0747 inch thick.

H. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

I. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

J. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

K. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: **[41 by 41 mm] [As indicated]** <Insert size>.
2. Material: Galvanized steel, ASTM A 653/A 653M, **[commercial steel, Type B] [structural steel, Grade 230]**, with Z275 coating; **[2.8-mm (12 gauge)] [2-mm (14 gauge)] [1.6-mm (16 gauge)]** nominal thickness.
3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, **[commercial steel, Type B] [structural steel, Grade 230]**; **[2.5-mm (12 gauge)] [1.7-mm (114 gauge)] [1.35-mm (16 gauge)]** minimum thickness; **[unfinished] [coated with rust-inhibitive, baked-on, acrylic enamel] [hot-dip galvanized after fabrication]**.

L. Aluminum Plate and Sheet: ASTM B 209M, Alloy 6061-T6.

M. Aluminum Extrusions: ASTM B 221M, Alloy 6063-T6.

N. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide **[Type 304][Type 316]** stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM F 568M, Property Class 4.6; with hex nuts, ASTM A 563M; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325M, Type 3; with hex nuts, ASTM A 563M, Class 8S3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 738M; with hex nuts, ASTM F 836M; and, where indicated, flat washers; Alloy **[Group A1 with Type 304] [Group A4 with Type 316L]**.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563M; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. [Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.]

G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

H. Post-Installed Anchors: **[Torque-controlled expansion anchors][or][chemical anchors]**.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **[Group A1 for Type 304] [Group A4 for Type 316L]** stainless-steel bolts, ASTM F 738M, and nuts, ASTM F 836M.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 41 by 22 mm by length indicated with anchor straps or studs not less than 75 mm long at not more than 200 mm o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Division 09 Sections on painting and on high performance coatings.

1. Ferrous metal - typical painting systems: Universal shop primer; fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

a. [Use primer with a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).]

2. Ferrous metal - polyurethane coating system: Moisture-cure organic zinc-rich primer complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

a. [Use primer with VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).]

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1 mm unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing**[and contour of welded surface matches that of adjacent surface]**.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 3.2 by 38 mm, with a minimum 150-mm embedment and 50-mm hook, not less than 200 mm from ends and corners of units and 600 mm o.c., unless otherwise indicated.

K. Galvanized Steel:

1. Fabricate items in accordance with Class **[I][II][III]** guidelines as described in AGA's Recommended Details for Galvanized Structures.
2. Use fabrication practices for products in accordance with applicable portions of ASTM A143, A384 and A385, except as specified herein. Avoid fabrication techniques which could cause distortion or embrittlement of steel.
3. Consult Project Director/COR regarding potential warpage problems or potential handling problems during the galvanizing process which may require modification of design before fabrication proceeds.
4. Remove welding slag and burrs prior to delivery for galvanizing.
5. Provide vent and drain holes and/or lifting lugs to facilitate handling during the galvanizing process that are suitable to Project Director/COR and fabricator.

    a. Locate holes so as not to be visible on exposed surfaces. If this is not possible, plug holes with zinc solder after galvanizing and file smooth. Do not fill holes indicated to remain as weep holes.
    b. Remove lifting lugs after galvanizing.

6. After galvanizing, fill holes that were required for the galvanizing process.
7. Remove, by blast cleaning or other methods, surface contaminants and coatings which would not be removable by normal chemical cleaning process in galvanizing operation.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes **[indicated] [recommended by partition manufacturer]** with attached bearing plates, anchors, and braces as **[indicated][recommended by partition manufacturer]**. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. [Galvanize miscellaneous framing and supports where indicated.]

E. [Prime miscellaneous framing and supports with [zinc-rich primer] [primer specified in Division 09 Section on "High-Performance Coatings"] where indicated.]

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 19-mm bolts, spaced not more than 150 mm from ends and 600 mm o.c. unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 50 mm larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize**[and prime]** shelf angles located in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, except for elevator pit ladders.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
3. Ladder safety cages are prohibited. Where height of fixed ladder exceeds 7315 mm, it shall have a personal fall arrest system (PFAS) compliant with OSHA 29 CFR 1910.28

B. Steel Ladders:

1. Space siderails 450 mm apart unless otherwise indicated.

2. Siderails: Continuous, **[9.5-by-64-mm] [12.7-by-64-mm]** steel flat bars, with eased edges.

3. Rungs: **[19-mm-] [25-mm-]** diameter steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than **[12 mm] [19 mm]** in least dimension.
8. Support each ladder at top and bottom and not more than 1500 mm o.c. with welded or bolted steel brackets.

9. Galvanize **[and prime]**exterior ladders, including brackets.
10. Prime interior ladders, including brackets and fasteners.

C. Safety Cages are prohibited.

2.9 METAL SHIPS' LADDERS

A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads shall be not less than 127 mm exclusive of nosing or less than 216 mm including the nosing, and riser height shall be not more than 241 mm.
2. Fabricate ships' ladders, including railings from steel.
3. Fabricate treads**[and platforms]** from **[welded or pressure-locked steel bar grating] [pressure-locked stainless-steel bar grating][pressure-locked aluminum bar grating] [extruded-aluminum plank grating]**. Limit openings in gratings to no more than **[12 mm] [19 mm]** in least dimension.
4. Fabricate treads and platforms from rolled-steel floor plate.

B. Galvanize **[and prime]**exterior steel ships' ladders, including treads, railings, brackets, and fasteners.

C. Prime interior steel ships' ladders.

2.10 METAL FLOOR PLATE

A. Fabricate from rolled-**[steel] [stainless-steel]** floor plate of thickness indicated below:

1. Minimum Thickness: **[3.2 mm][4.8 mm][6.4 mm][8 mm][9.5 mm][As indicated]**.

B. Provide **[steel][stainless-steel]** angle supports as indicated.

C. Include **[steel][stainless-steel]** angle stiffeners, and fixed and removable sections as indicated.

D. Provide flush **[steel][stainless-steel]** bar drop handles for lifting removable sections, one at each end of each section.

2.11 ELEVATOR PIT SUMP COVERS

A. Fabricate from **[3.2-mm][4.8-mm]** rolled-steel floor plate with four 25-mm- diameter holes for water drainage and for lifting.

B. Provide steel angle supports as indicated.

2.12 STEEL BAR GRATES

A. Acceptable manufacturer: Manufacturer specializing in fabrication of types of units required, who has tested units for load-bearing strength and deflection, and has currently published load tables based on recognized test procedures.

B. Comply with NAAMM MBG 531, “Metal Bar Grating Manual.”

C. Cross bars: Rectangular.

D. Bearing bars: Rectangular.

E. Surface: **[Plain][Serrated]**.

F. Fabrication:

1. Fabricate grates by welding steel bars.
2. Weld toe plates to grate where required.
3. Do not notch bearing bars at supports.
4. Provide welded trim bars of same size and shape as bearing bars to edges and openings.

G. Removable Grates:

1. Provide secure anchorage which can be removed from inside only, or make grate removable by use of special tools at exterior if there is no access from inside. Where applicable, provide locking design in accordance with OBO Code requirements.
2. Furnish special tools to Project Director/COR.

H. Hinged Grates:

1. Provide hinged sections where indicated; out-opening.
2. Provide minimum two galvanized hinges per section; hinge quantity and size as required for dimensions of hinged sections.
3. **[Provide latch mechanism to allow opening of hinged sections from inside without use of tools or keys. Provide latch guards to prevent release of latch from outside.]**
4. **[Provide steel hasp drilled for padlock.]**

I. Grates exposed to foot traffic: Provide maximum opening width of 6 mm.

J. Provide **[galvanized steel][stainless steel]** grates.

2.13 ALUMINUM BAR GRATES

A. Bearing Bars: 31 mm x 3 mm aluminum 6063 T5 alloy, spaced at 25 mm on center with spacers at 100 mm on center, staggered.

B. Finish: Mill.

2.14 GENERAL METAL BOLLARDS

A. The requirements of this Article relate to metal bollards which are not use for anti-ram security.

B. Fabricate metal bollards from Schedule 40 steel pipe.

1. Cap bollards with 6-mm (1/4-inch-) thick steel plate.
2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

C. [Fabricate bollards with 10-mm- (3/8-inch-) thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 19-mm (3/4-inch) anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.]

D. Fabricate sleeves for bollard anchorage from steel pipe with 6-mm (1/4-inch-) thick steel plate welded to bottom of sleeve. Make sleeves not less than 200 mm (8 inches) deep and 19 mm (3/4 inch) larger than OD of bollard.

E. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 6-mm- (1/4-inch) wall-thickness steel tubing with an OD approximately 1.5 mm (1/16 inch) less than ID of bollards. Match drill sleeve and bollard for 19-mm (3/4-inch) steel machine bolt.

F. Prime bollards with **[zinc-rich primer.][primer specified in Section 099605 "High-Performance Coatings."]**

2.15 ANTI-RAM BOLLARDS

A. Fabricate anti-ram bollards in accordance with DS approved security details in the “DS Security Detail Handbook (Red Book),” and in accordance with Construction Drawings.

B. Refer to the Article on FABRICATION, GENERAL for additional general fabrication requirements.

C. Finish: All exterior steel related to bollards and anti-ram assemblies shall be **[galvanized][stainless steel]**.

2.16 FORCED-ENTRY (FE) AND BALLISTIC-RESISTANCE (BR) PENETRATION SECURITY ASSEMBLIES

A. Fabricate assemblies in accordance with DS approved security details in the “DS Security Detail Handbook (Red Book),” and in accordance with Construction Drawings.

B. Refer to the Articles on FABRICATION, GENERAL and on FASTENERS for general fabrication requirements.

C. Finish:

1. All interior steel assemblies shall be prime coated or galvanized, unless noted as stainless steel on the Construction Drawings.
2. All exterior steel assemblies shall be **[galvanized][stainless steel]**.

2.17 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize **[and prime]**exterior miscellaneous steel trim. **<Confirm and specify coating requirements where stainless steel trim elements are required, such as where exposed to corrosive atmospheres.>**

D. Prime interior miscellaneous steel trim.

2.18 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with **[zinc-rich primer.][primer specified in Section 099600 "High-Performance Coatings."]**

2.19 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 200 mm unless otherwise indicated.

C. Galvanize **[and prime]**loose steel lintels located in exterior walls. **<Confirm and specify coating requirements where stainless steel loose lintels are required, such as where exposed to corrosive atmospheres.>**

D. Prime loose steel lintels located in exterior walls with **[zinc-rich primer.][primer specified in Section 099600 "High-Performance Coatings."]**

E. Prime interior loose steel lintels.

2.20 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.21 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.22 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop Preparation for Galvanized Metal: Clean galvanized metal surfaces designated to be field painted in accordance with SSPC-SP1, “Solvent Cleaning,” followed by SSPC-SP2, “Hand Tool Cleaning,” or SSPC-SP3, “Power Tool Cleaning.”

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with **[SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."][SSPC-SP 3, "Power Tool Cleaning."][requirements indicated below:]**

1. [Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3. Items Indicated to Receive Primers Specified in Division 09 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."]

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.23 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend to finish.

1. At all welds: Remove oxides, carbon precipitation, and weld splatter at or around welded joints and passivate surfaces in accordance with ASTM A380 and ASTM A967.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces in accordance with ASTM A380 and ASTM A967. Remove embedded foreign matter and leave surfaces chemically clean.

2.24 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. General Corrosion Protection:

1. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
2. Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

   a. Cast Aluminum: Heavy coat of bituminous paint.
   b. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING ANTI-RAM BOLLARDS AND FE/BR SECURITY ASSEMBLIES

A. Install in accordance with DS approved security details in the “DS Security Detail Handbook (Red Book),” and in accordance with Construction Drawings.

3.3 INSTALLING LADDERS

A. Coordinate with concrete formwork and pouring of concrete.

B. Coat portion of rungs to be embedded in concrete with heavy coat of bituminous paint. Do not extend coating onto exposed surfaces.

3.4 INSTALLING BAR GRATINGS

A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

3.5 INSTALLING GENERAL METAL BOLLARDS

A. Fill bollards solidly with concrete.

1. For bollards with decorative caps, fill with concrete and allow to cure seven days before installing.
2. For bollards without caps, mound top surface to shed water
3. Do not fill removable bollards or bollards receiving light fixtures with concrete.

B. [Anchor bollards to existing construction with [expansion anchors] [anchor bolts] [through bolts]. Provide four 19-mm (3/4-inch) bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 100 mm (4 inches) in concrete.]

C. Anchor bollards in place with concrete footings. Center and align bollards in holes 75 mm (3 inches) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

D. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 75 mm (3 inches) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

E. Place removable bollards over internal sleeves and secure with 19-mm (3/4-inch) machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.

3.6 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.7 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for **[operable partitions][, overhead doors,] [and] [overhead grilles]** securely to, and rigidly brace from, building structure.

3.8 ADJUSTING AND CLEANING

A. [Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 0.05-mm dry film thickness.]

B. [Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Sections on painting and on high performance coatings.]

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055005

SECTION 057005 - DECORATIVE METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative mechanical grilles and frames.
2. Custom door pulls.
3. Combination hall push-button stations.
4. Metal reveals at wood paneling.

B. Related Requirements:

1. Section 057305 "Decorative Metal Railings" for decorative metal railings.

1.2 COORDINATION

A. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details for decorative metal.

1. Include plans, elevations, component details, and attachment details.
2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.

E. Samples for Initial Selection: For products involving selection of color, texture, or design**[including mechanical finishes]**.

F. Samples for Verification: For each type of exposed finish.
   1. Sections of linear shapes.
   2. Full-size Samples of castings and forgings.

      a. For custom castings, submit finished Samples showing ability to reproduce detail**[, cast-metal color,]** and quality of finish.**[Samples may be of similar previous work.]**

   3. Samples of **[welded] [and] [brazed]** joints showing quality of workmanship**[and color matching of materials]**.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[fabricator] [organic-coating applicator] [anodic finisher] [powder-coating applicator]**.
B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Installer Qualifications: Fabricator of products.

C. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

F. Welding Qualifications: Qualify procedures and personnel according to the following:

   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

G. Sample Installation: Build sample installation to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build sample installation for the following types of decorative metal:

a. <Insert, in separate subparagraphs, description of each decorative metal type including sample installation size>.

2. Subject to compliance with requirements, approved sample installations may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by enough packing material to ensure that products are not cracked or otherwise damaged.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Use materials with smooth, flat surfaces unless otherwise indicated. Use materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.2 ALUMINUM

A. Fabricate products from alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

B. Bars and Shapes: ASTM B 221M (ASTM B 221), Alloy 6063-T5/T52.

C. **[Pipe] [and] [Round Tubing]**: ASTM B 429/B 429M, Alloy 6063-T6.

D. Tubing: ASTM B 210M (ASTM B 210), Alloy 6063-T832.

E. Plate and Sheet: ASTM B 209M (ASTM B 209), **[Alloy 3003-H14] [Alloy 5005-H32] [Alloy 6061-T6]**.

F. Forgings: ASTM B 247M (ASTM B 247), Alloy 6061-T6.

G. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.3 COPPER AND COPPER ALLOYS

A. Fabricate products from alloys indicated and temper to suit application and forming methods but with strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.

2.4 BRONZE

A. Extruded Shapes: ASTM B 455, Alloy UNS C38500 (architectural bronze).

B. Pipe: ASTM B 43, Alloy UNS C23000 (red brass, 85 percent copper).

C. Tube: ASTM B 135M (ASTM B 135), Alloy UNS C23000 (red brass, 85 percent copper).

D. Castings: ASTM B 62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass) or ASTM B 584, Alloy UNS C86500 (No. 1 manganese bronze).

E. Plate, Sheet, Strip, and Bars: ASTM B 36/B 36M, Alloy UNS C28000 (muntz metal, 60 percent copper).

2.5 BRASS

A. Extruded Shapes: ASTM B 249/B 249M, Alloy UNS C36000 (free-cutting brass).

B. Seamless Tube: ASTM B 135M (ASTM B 135), Alloy UNS C26000 (cartridge brass, 70 percent copper).

C. Castings: ASTM B 584, Alloy UNS C85200 (high-copper yellow brass).

D. Plate, Sheet, Strip, and Bars: ASTM B 36/B 36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).

2.6 NICKEL SILVER

A. Extruded Shapes: ASTM B 249/B 249M, Alloy UNS C79600.

B. Castings: ASTM B 584, Alloy UNS C97300 (12 percent leaded nickel silver).

2.7 COPPER

A. Tube: ASTM B 75/B 75M, Alloy UNS C12200 (phosphorous deoxidized, high residual phosphorous copper).

B. Castings: ASTM B 824, with a minimum of 99.9 percent copper.

C. Plate, Sheet, Strip, and Bars: ASTM B 152/B 152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

2.8 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 304.

B. Pipe: ASTM A 312/A 312M, Grade TP 304.

C. Castings: ASTM A 743/A 743M, Grade CF 8 or Grade CF 20.

D. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.

E. Bars and Shapes: ASTM A 276, Type 304.

F. Wire Rope and Fittings:

1. Wire Rope: **[1-by-19] [7-by-7] [7-by-19]** <**Insert designation**> wire rope made from wire complying with ASTM A 492, Type 316.
2. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain without failure a load equal to minimum breaking strength of wire rope with which they are used.

2.9 STEEL AND IRON

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25]** <**Insert value**> percent.

B. Tubing: ASTM A 500/A 500M (cold formed) or ASTM A 513, Type 5 (mandrel drawn).

C. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.

D. Plates, Shapes, and Bars: ASTM A 36/A 36M.

E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M unless otherwise indicated.

F. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel or structural steel, exposed.

2.10 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:
   1. Aluminum Items: **[Aluminum] [Type 304 stainless-steel]** fasteners.
   2. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, muntz metal (Alloy 280) fasteners where exposed.
   3. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, brass (Alloy 260 or 360) fasteners where exposed.
   4. Stainless-Steel Items: Type 304 stainless-steel fasteners.
   5. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless-steel fasteners where exposed.
   6. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
   7. Dissimilar Metals: Type 304 stainless-steel fasteners.

B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless **[otherwise indicated] [exposed fasteners are unavoidable]**.

   1. Provide Phillips tamper-resistant or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on **[ICC-ES AC193] [ICC-ES AC308]**.

   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941M (ASTM F 1941), Class Fe/Zn 5 unless otherwise indicated.
   2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group A1 (1) stainless-steel bolts, ASTM F 738M (ASTM F 593), and nuts, ASTM F 836M (ASTM F 594).

2.11 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

   1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.

C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

F. Shop Primers: Provide primers that comply with Division 09 Section, “Painting and Finishing.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.12 FABRICATION, GENERAL

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1 mm (1/32 inch) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.

J. Comply with AWS for recommended practices in shop **[welding] [and] [brazing]**. **[Weld] [and] [braze]** behind finished surfaces without distorting or discoloring exposed side. Clean exposed **[welded] [and] [brazed]** joints of flux, and dress exposed and contact surfaces.

1. Where **[welding] [and] [brazing]** cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for **[Type 1 Welds: no evidence of a welded joint] [Type 2 Welds: completely sanded joint, some undercutting and pinholes okay] [Type 3 Welds: partially dressed weld with spatter removed] [Type 4 Welds: good quality, uniform undressed weld with minimal splatter]**.

K. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

2.13 DECORATIVE MECHANICAL GRILLES

A. Fabricate decorative grilles from perforated **[aluminum] [brass] [bronze] [stainless-steel] [steel]** sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.

B. Drill and countersink grilles for mounting screws at 50 mm (2 inches) from corners and at 250 mm (10 inches) or less o.c. Provide units with oval-head self-tapping machine screws.

C. Fabricate grille frames from extruded **[aluminum] [brass] [bronze] [stainless-steel] [steel]** of profiles and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates **[welded] [brazed]** to back of frames.

1. Secure grilles in frames with 12-mm- (0.5-inch-) long **[welds] [brazing]** along perimeter of grilles at 100 mm (4 inches) o.c.
2. Provide frame profiles to match existing frames.
3. Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by Project Director/COR.

D. Drill and countersink frames for mounting screws at 100 mm (4 inches) from corners and at 400 mm (16 inches) or less o.c. Provide units with oval-head self-tapping machine screws.

2.14 CUSTOM DOOR PULLS FOR NON-FEBR DOORS

A. Fabricate custom door pulls from **[brass] [bronze] [stainless-steel]** bar stock of profile indicated, fabricated to shapes indicated. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile. Drill and tap door pulls to receive through bolts for attachment to doors.

B. Fabricate backing plates for custom door pulls from 3.2-mm (1/8-inch) **[brass] [bronze] [stainless-steel]** sheet. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal. Drill and countersink holes where indicated for screws and bolts.

C. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

2.15 COMBINATION HALL PUSH-BUTTON STATIONS

A. Fabricate units of **[brass] [bronze] [stainless steel]** to comply with details indicated. Coordinate with elevator signal equipment to provide integrated, closely fitted assemblies.

1. Fabricate faceplates from 3.2-mm- (1/8-inch-) thick sheet with edges beveled at a 45-degree angle for one-half thickness of metal.
2. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal 100-mm (4-inch) wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are 250 by 250 by 90 mm (10 by 10 by 3-1/2 inches) in depth.
3. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of 1.6 mm (1/16 inch) with engraving painted red. Make signs 125 mm (5 inches) wide by 200 mm (8 inches) high.
4. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station**[, card reader,]** and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

2.16 METAL REVEALS

A. Fabricate metal reveals for wood paneling from **[19-by-19-by-3-mm (3/4-by-3/4-by-1/16-inch) extruded-bronze] [19-by-19-by-0.6-mm (3/4-by-3/4-by-0.025-inch) brake-formed, stainless-steel]** channels. Drill for mounting screws 150 mm (6 inches) from ends of channels and not more than 600 mm (24 inches) o.c. Locate mounting screws at same heights for all channels. Provide **[black-finished,]**hex-socket, wafer-head screws for mounting reveals.

2.17 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.18 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm]** or thicker.

C. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm]** or thicker.

1. Color: **[Champagne] [Light bronze] [Medium bronze] [Dark bronze] [Black]** <Insert color>.
2. Color: **[Match Project Director/COR's sample] [As selected by Project Director/COR from full range of industry colors and color densities]**.

D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 0.04 mm (1.5 mils). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]** <Insert color and gloss>.

E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.005 mm (0.2 mil) for primer and 0.02 mm (0.8 mil) for topcoat.

1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]**.

F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with **[AAMA 2604] [AAMA 2605]** and containing not less than **[50] [70]** percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]** <Insert color and gloss>.

G. High-Performance Organic Finish: **[Three] [Four]**-coat fluoropolymer finish complying with AAMA 2605 and containing not less than **[50] [70]** percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]** <Insert color and gloss>.

2.19 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).

C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).

D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).

E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

F. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 0.025 mm (1 mil).

G. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 0.025 mm (1 mil).

H. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 0.025 mm (1 mil).

I. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below):

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 0.025 mm (1 mil).

J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide)**[, with color matching Project Director/COR's sample]**.

K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate)**[, with color matching Project Director/COR's sample]**.

L. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)**[, with color matching Project Director/COR's sample]**:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 0.025 mm (1 mil).

M. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air dried; Mechanical Finish: buffed, as specified; Coating: clear, organic, air dried, as specified below)**[, with blackening and buffing matching Project Director/COR's sample]**:

1. Clear, Organic Coating: Lacquer specified for copper alloys; applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 0.025 mm (1 mil).

2.20 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

D. Directional Satin Finish: No. 4.

E. Dull Satin Finish: No. 6.

F. Reflective, Directional Polish: No. 7.

G. Mirrorlike Reflective, Nondirectional Polish: No. 8.

H. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

I. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.

1. Product: Subject to compliance with requirements, provide INCO colored stainless-steel finish as developed and licensed by International Nickel Co., Ltd.
2. Color: **[Match Project Director/COR's sample] [As selected by Project Director/COR from finisher's full range]**.

2.21 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123/A 123M.

1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A 153/A 153M.
2. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

C. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with **[SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."] [SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."] [requirements indicated below:]**

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

D. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated ferrous-metal surfaces with **[universal shop primer] [primers specified in Division 09 Section "Exterior Painting."] [primers specified in Division 09 Section "Interior Painting."]** unless **[zinc-rich primer is] [primers specified in Division 09 Section "High-Performance Coatings" are]** indicated.
2. Do not apply primer to galvanized surfaces.

E. Shop-Painted Finish: Comply with **[Division 09 Section "Exterior Painting."] [Division 09 Section "High-Performance Coatings."]**

1. Color: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]**.

F. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Color: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]**.

G. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 0.04 mm (1.5 mils).
4. Color: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]**.

H. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 0.04 mm (1.5 mils).
4. Color: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range]**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

H. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.

I. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLING DECORATIVE MECHANICAL GRILLES

A. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.

1. Secure to framing and blocking with specified fasteners.
2. On marble, brick, and other solid surfaces, secure with wood screws in plastic plugs.

3.4 INSTALLING CUSTOM DOOR PULLS

A. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head **[wood] [self-tapping metal]** screws and secure pulls through doors and backing plates with oval-head machine screws.

3.5 INSTALLING COMBINATION HALL PUSH-BUTTON STATIONS

A. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components. Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

3.6 INSTALLING METAL REVEALS AT WOOD PANELING

A. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

3.7 CLEANING AND PROTECTION

A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

B. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

C. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 0.05-mm (2.0-mil) dry film thickness.

D. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Section, “Painting and Finishing.”

E. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

F. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.

G. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION 057005

SECTION 057305 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stainless-steel decorative railings.
2. Post-supported railings with glass infill.
3. Preparation, coordination, fabrication and installation of Work.
4. Anchors, supports, inserts and fasteners.
5. Finishing.

B. Products Furnished But Not Installed Under This Section: Provide templates for anchor and bolt installation specified in other Sections.

C. Related Requirements:

1. **[Division 06 Section "Rough Carpentry"] [Division 06 Section "Miscellaneous Rough Carpentry"]** for wood blocking for anchoring railings.
2. **[Division 06 Section "Exterior Architectural Woodwork"] [Section 064023 "Interior Architectural Woodwork"]** for wood railings.
3. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.

1.2 DEFINITIONS

A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas and for pedestrian guidance and support, visual separation, or wall protection.

B. Guardrail: A system of building components located near open sides of elevated walking surfaces for purpose of minimizing possibility of accidental fall from walking surface to lower level.

C. Handrail:

1. Horizontal or sloping rail grasped by hand for guidance or support, and for arresting falls on adjacent walking surface.
2. Handrails may form part of a guardrail system.

D. Weld: Braze, solder or weld, as applicable for the particular type, alloy and gage of metal, and as recommended by AISI, AWS, CDA and NAAMM.

1.3 COORDINATION AND SCHEDULING

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not meet structural performance requirements.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Professional Certification: Provide Shop Drawings and engineering calculations prepared and sealed by Registered Professional Engineer, licensed in Project jurisdiction, for railings.

B. Product Data: For the following:

1. Manufacturer's product lines of railings assembled from standard components.
2. Grout, anchoring cement, and paint products.

C. Shop Drawings: Include plans, elevations, sections, and attachment details.

1. Include anchorage and accessory items and integration details of related Work.

D. Samples for Initial Selection: For products involving selection of color, texture, or design**[, including mechanical finishes]**.

E. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters; 300 mm square for sheet or plate and 300 mm long for extrusions or running trim.
2. Fittings and brackets.
3. Welded connections.
4. Submit samples with adhered protective film laminate to preserve finish.

F. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Calculations, Submit, for information only, engineering calculations.

B. Qualification Data: For **[professional engineer] [testing agency]**.

C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

D. Welding certificates.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

F. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: Submit cleaning and maintenance data for materials provided.

1.8 QUALITY ASSURANCE

A. Designer/Engineer Qualifications: Design elements required to meet structural requirements under direct supervision of a Registered Professional Engineer, licensed in Project jurisdiction.

B. Installer and Fabricator Qualifications: Not less than 5 years documented, successful experience in fabrication of custom work similar to Work of this Project.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

a. Finish 1: No evidence of a welded joint.

D. Sample Installation: Build sample installations to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build sample installations as shown on Drawings.
2. Build sample installations for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are not less than 600 mm (24 inches) in length.
3. Subject to compliance with requirements, approved sample installations may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design railings, including attachment to building construction.

B. Glazing in Permanent Railing Systems, Guards, and Balustrades: ASTM E2358.

C. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Stainless Steel: 60 percent of minimum yield strength.

D. Design Requirements:

1. Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished product for use intended.
2. Design and fabricate components to support loads indicated or required to comply with requirements of authorities having jurisdiction over Project.
3. Design modifications:

a. May be proposed by manufacturer to satisfy performance requirements.
b. Must conform to design and specified durability and strength.
c. Must maintain profiles and alignments indicated.

E. Structural Requirements:

1. Design, fabricate and install to support gravity loads and loads of related components as required for proper support and rigidity of configurations indicated, including provisions for deflection, expansion and contraction forces.
2. Handrails:

a. Capable of withstanding concentrated load of 200 lb-f (890 N) applied in any direction at any point along the top, and uniform load of 50 lb-f/lf (730 N/m) applied in any direction at the top, when tested according to ASTM E935.
b. Design in accordance with ASTM E985, to withstand concentrated load of 300 lb-f (1335 N) applied in any direction at any point along the top, and uniform load of 50 lb-f/linear foot (730 N/m) applied in any direction at the top, when tested according to ASTM E935.
c. Do not assume uniform and concentrated loads act concurrently.

3. Guardrails:

a. Toprails:

1) Capable of withstanding concentrated load of 200 lb-f (890 N) applied in any direction at any point along the top, and uniform load of 50 lb-f/lf (730 N/m) applied in any direction at the top, when tested according to ASTM E935.
2) Do not assume uniform and concentrated loads act concurrently.

b. Intermediate rails/infill area: Capable of withstanding horizontal concentrated load of 50 lb-f (220 N) applied on a 1 square foot (.09 square meters) area at any point, including intermediate rails or similar elements.

F. Visual Requirements:

1. Metal surfaces:

a. Fabricate surfaces exposed to view from materials which are smooth and free of surface blemishes.
b. Do not use materials which have stains and discolorations, including welds, exposed in completed Work.

2. Surface flatness and edges: For exposed Work provide cold-rolled, cold-finished, cold-drawn, extruded, machine cut materials produced to commercial standard for flatness with edges and corners sharp and true to angle or curvature required.
3. Perform welding, brazing and soldering such that surfaces exposed to view in completed Work will be free of pitting, runs, spatter, cracks, warping, dimpling, depressions, distortion, discoloration and other imperfections.

G. Interface With Other Systems:

1. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchors, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which will be embedded in concrete or masonry construction.
2. Coordinate delivery of such items to Project site.

H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 67 deg C (120 deg F), ambient; 100 deg C (180 deg F), material surfaces.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
3. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.
4. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.

2.3 STAINLESS STEEL

A. Alloys and Tempers:

1. Provide alloys which will weld and machine properly, and will finish to match COR's sample and adjacent components of assembly.
2. Use temper or hardness to provide greatest strength and durability, consistent with necessary forming, fabrication and finishing processes.

B. Tubing: ASTM A 554, **[Grade MT 304] [Grade MT 316] [Grade MT 316L]**.

C. Pipe: ASTM A 312/A 312M, **[Grade TP 304] [Grade TP 316] [Grade TP 316L]**.

D. Castings: ASTM A 743/A 743M, **[Grade CF 8 or CF 20] [Grade CF 8M or CF 3M]**.

E. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, **[Type 304] [Type 316] [Type 316L]**.

F. Bars and Shapes: ASTM A 276, **[Type 304] [Type 316] [Type 316L]**.

2.4 GLASS AND GLAZING MATERIALS

A. Safety Glazing: Glazing shall comply with 16 CFR 1201, Category II.

B. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.

1. Glass Color: Clear.
2. Thickness for Glass Infill Panels: As required by structural loads, but not less than 10.0 mm.
3. Manufacturing Process: Manufacture fully tempered glass as follows:

a. By vertical (tong-held) or horizontal (roller-hearth) process, at manufacturer's option.

C. Laminated Glass: ASTM C 1172, Condition A (uncoated), Type I (transparent flat glass), Quality-Q3 with two plies of glass and ionoplast interlayer not less than 0.060 inch 1.52 mm thick.

1. Kind: LT (laminated tempered).
2. Glass Color: Clear.
3. Interlayer Color: Clear.
4. Glass Plies for Glass Infill Panels: Thickness required by structural loads, but not less than 5.0 mm each.

D. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC or another certification agency acceptable to Project Director/COR based on input from OBO/PDCS/DE. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

E. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.

2.5 FASTENERS

A. Fastener Materials: Unless otherwise indicated, provide the following:

1. Stainless-Steel Components: **[Type 304] [Type 316]** stainless-steel fasteners.
2. Dissimilar Metals: **[Type 304] [Type 316]** stainless-steel fasteners.

B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated**[and capable of withstanding design loads]**.

C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless **[otherwise indicated] [exposed fasteners are unavoidable] [exposed fasteners are the standard fastening method for railings indicated]**.

1. Provide **[Phillips] [tamper-resistant] [square or hex socket]** flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193**[or ICC-ES AC308]**.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941M (ASTM F 1941), Class Fe/Zn 5, unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **[Group A1 (1)] [Group A4 (2)]** stainless-steel bolts, ASTM F 738M (ASTM F 593), and nuts, ASTM F 836M (ASTM F 594).

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.7 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1 mm (1/32 inch) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded or nonwelded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds; no evidence of a welded joint.

I. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

J. Form changes in direction as follows:

1. By bending or by inserting prefabricated elbow fittings.

K. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of hollow railing members with prefabricated end fittings.

M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 6 mm (1/4 inch) or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

P. For railing posts set in concrete, provide stainless-steel sleeves not less than 150 mm (6 inches) long with inside dimensions not less than 13 mm (1/2 inch) greater than outside dimensions of post, with metal plate forming bottom closure.

2.8 GLAZING PANEL FABRICATION

A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

1. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces.
2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.

B. Infill Panels: Provide **[tempered] [laminated, tempered] glass panels[for both straight and curved sections]**.

2.9 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.10 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.

C. Directional Satin Finish: ASTM A 480/A 480M, No. 4.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 2 mm in 1 m (1/16 inch in 3 feet).
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 5 mm in 3 m (1/4 inch in 12 feet).

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 50 mm (2 inches) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 150 mm (6 inches) of post.

3.4 ANCHORING POSTS

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than 125 mm (5 inches) deep and 20 mm (3/4 inch) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, **[welded to post after placing anchoring material] [attached to post with set screws].**

D. Leave anchorage joint exposed with **[3-mm (1/8-inch) buildup, sloped away from post] [anchoring material flush with adjacent surface]**.

E. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

3.5 ATTACHING RAILINGS

A. Anchor railing ends to concrete and masonry with **[sleeves concealed within] [flanges connected to] [brackets on underside of rails connected to]** railing ends and anchored to wall construction with anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and **[welded to railing ends] [or] [connected to railing ends using nonwelded connections]**.

C. Attach handrails to walls with wall brackets**[except where end flanges are used]**. Provide brackets with 38-mm (1-1/2-inch) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

1. Use type of bracket with **[flange tapped for concealed anchorage to threaded hanger bolt] [predrilled hole for exposed bolt anchorage]**.
2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets**[and railing end flanges]** to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into**[fire-retardant-treated]** wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.
6. For steel-framed partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 INSTALLING GLASS PANELS

A. Post-Supported Glass Railings: Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles. Erect posts and other metal railing

components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Project Director/COR will engage a qualified testing agency to perform tests and inspections and to prepare test reports. Payment for these services will be made by Project Director/COR.

B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.

C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Project Director/COR and comply with specified requirements.

D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

E. Glazing in Permanent Railing Systems, Guards, and Balustrades shall be tested, at Contractor’s expense, according to ASTM E2353-21.

3.8 CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

3.9 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION 057305

SECTION 061719 - CROSS-LAMINATED TIMBER PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes framing using structural cross-laminated timber (CLT) panels and their connections.

1.2 REFERENCE STANDARDS

A. IBC 2024 – International Building Code

B. APA PRG 320-2019 - Standard for Performance-Rated Cross-Laminated Timber

C. ANSI/AWC NDS 2021 – National Design Specification for Wood Construction.

D. ANSI 405-2018 – Standard Adhesives for Use in Structural Glued Laminated Timber

E. ALSC PS-20-20 – American Softwood Lumber Standard Product Standard 20

F. ASCE 7-16 – Minimum Design Loads for Buildings and Other Structures

G. AWS D1.1:2020 – Structural Welding Code - Steel

H. <add/subtract>

1.3 PERFORMANCE REQUIREMENTS FOR DELEGATED DESIGN

A. CLT and connectors shall be engineered by a registered design professional in the state in which the Project is located, using the performance requirements and design criteria indicated in this section and the Contract Documents.

B. CLT and connectors shall withstand the effects of structural loads shown on the Drawings in accordance with ASCE 7.

C. Member and connection designs shall conform to NDS.

D. Where alternative materials and methods of design are used, it is the responsibility of the delegated registered design professional to attain approval from the Authority Having Jurisdiction.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include report data on CLT, adhesives, fabrication, and protection.
2. Sealers, coatings, moisture barriers and similar architectural finishes.
3. Adhesives, caulking, and tape.
4. Fasteners and connection hardware, including installation instructions.

B. Samples: Submit three samples for each type of architectural appearance grade CLT panel, with factory sealer or finish, as applicable. Size: 12 inch x12 inch.

C. Shop Drawings.

1. Installation drawings.

a. Indicate member locations, elevations, and spacing. Label each CLT panel with a piece number or other unique mark.
b. Indicate the interface of CLT panels to adjacent supporting structure and elements and components.
c. Do not reproduce details from the structural Contract Documents for use as installation drawings.

2. Piece drawings for each CLT panel:

a. Show layout, dimensions, and elevations of each panel.
b. Clearly indicate layup type, stress grade, appearance classification, and shop finishes.
c. Include dimensioned details of cuts, openings, holes, fasteners, and connection hardware.
d. Provide weight and center of gravity coordinates of each panel

3. Piece drawings for steel hardware connections.

a. Show layout, dimensions, thicknesses, and detail for each connection.
b. Provide, weld sizes, weldment type, and bolt assemblies.
c. Indicate primer coating or other finishes to be applied.

D. Operations & Maintenance Manual: Provide manufacturer’s maintenance and operation data for material components within this section. In addition to items specified in Division 01 Section "Systems Manual / O&M Data," includes the following data:

1. Procedures and schedules for inspecting, monitoring, and repairing CLT assemblies.
2. Procedures on mounting or penetrating CLT units for future MEP infrastructure expansion.

E. CLT supplier to provide an accurate fully detailed three-dimensional (3D) model of the interfaces (supports, abutments, etc.), CLT panels, secondary timber members, plus all connections prior to submission of shop drawings. Model shall be generated using Cadwork V25 or higher, or

approved alternate (compatible with AutoCAD 2011 and Revit 2018). 3D model shall use as-built X, Y, Z coordinates of structure and foundations that support CLT.

F. Moisture Control Method Statement: The Contractor shall submit for record a written statement of the means and methods employed to monitor and manage the effects of moisture exposure on the CLT during construction.

G. Installation Method Statement: The Contractor shall hire a registered design professional to author and submit for record a written statement of the means and methods employed for the installation and temporary support of CLT panels and supporting structure during construction.

H. Structural Drawings and Calculations for the Delegated Design of CLT panels and connections.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Label individual CLT panels with the 3rd party mark demonstrating it complies with APA PRG 320. Acceptable 3rd party marks include, APA, PFS-TECO, and Intertek.

B. Installer Qualifications: Company specializing in performing work of the type specified and with a minimum three years of documented experience.

C. Pre-installation meeting: Prior to performing CLT installation work on site, the Contractor shall initiate a pre-installation meeting to review installation procedures, connection procedures, and inspection requirements. At a minimum the meeting shall include representatives from the following: Contractor, Owner's Representative, Authority Having Jurisdiction, Testing Laboratory, CLT manufacturer, Structural Engineer, and CLT Installer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage and protection to be coordinated by the manufacturer with the installer and the Contractor.

B. Support CLT panels during shipment on non-marking material in the same positions as during storage.

C. Store CLT panels to prevent staining, cracking, distortion, warping or other physical damage.

1. Place stored panels so identification marks are clearly visible.
2. Store with adequate bracing.
3. Protect panels to prevent contact with the ground surface and water splash.
4. Separate panels with striping to allow air circulation around all faces of members.
5. Slit underside of membrane covering during storage on site.
6. Do not deface CLT panels

D. Handle and transport CLT panels in a position consistent with their shape and design in order to avoid excessive stresses that would cause splitting or damage. Protect corners and edges with wood blocking.

E. Lift and support CLT panels only at designated points indicated in the Contractor's Installation Method Statement.

F. Cover stored CLT panels on top and sides with a water repellant membrane in a manner that does not trap moisture.

1.7 EXTRA MATERIALS

A. Provide manufacturer's standard maintenance devices (e.g., special tools) associated with inspecting, monitoring, and torquing assembly components. Provide protective covering and labeling to facilitate storage and retrieval.

B. Provide extra materials as specified below. Extra materials shall match the products installed. Package these materials with protective covering for storage and include labels describing content:

1. Manufacturer's CLT Repair Kits: Two (2)
2. Bolts, Fasteners, Brackets: 1 percent of each type installed, but not less than one complete assembly connection.
3. Field-applied Coatings: Two (2) standard size containers of each type.

1.8 WARRANTY

A. Furnish the manufacturer's two-year warranty that assures the CLT product will be free of defects in material and workmanship from the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Vendor and Product:

1. <list>

2.2 MATERIALS

A. CLT Lamination type and thickness: lumber laminations 3rd party stress graded per grading rules that comply with ALSC PS 20 or CLSAB CSA O141. Lamination thickness varies as indicated in the manufacturers Product Evaluation Report.

B. CLT Moisture Content: 12% plus or minus 3% at time of manufacture.

C. CLT Use Classification: Dry service classification.

D. CLT Appearance Classification: Industrial or Architectural Appearance on one or two faces shall be specified in The Drawings and meet the criteria listed in Manufacturer's product definition. At a minimum, appearance classifications in APA PRG 320 Appendix A shall govern.

E. Fasteners: As specified on the Drawings and satisfying the following:

1. Nails shall conform to the NDS or ASTM F1667
2. Threaded fasteners shall conform to NDS. Proprietary fasteners shall be approved for use by the AHJ based on testing to ICC Acceptance Criteria 233.

F. Steel Hardware: As specified on the Drawings and satisfying the following.

1. Structural Steel: ASTM A36, Fy=36ksi, Fu=58ksi
2. Gauge Steel Straps and Hangers: Proprietary products approved for use by the AHJ based on testing to ICC Acceptance Criteria 13.
3. Primer: Primer paint shall be zinc rich SSPC-Paint 20, Type II, Organic and comply with all applicable SSPC requirements. Where a finish coat is applied, the contractor shall verify compatibility.
4. Weldment: Low Hydrogen E70XX electrodes conforming to AWS.
5. Bolt assemblies: ASTM A325, Hot-Dip Galvanized, threads excluded from shearing planes.

G. Adhesive Tape: Rothoblaas Flexi Band

H. Subfloor Construction Adhesive: Henkel/Loctite PL400 conforming to ASTM D3498.

I. Plywood: As specified on the Drawings and satisfying the following:

1. Conform to the requirements of DOC PS1, DOC PS 2, or APA PRP 210.
2. Exterior or Exposure 1 type.

J. End Grain Sealer: <List>

K. <Add other Structural Connection products/materials i.e. Threaded Rod Adhesives>

2.3 FABRICATION

A. Fabricate finished CLT panels to APA PRG 320 tolerances unless noted otherwise.

B. Tolerance of cut-out and opening edge locations and center of hole locations within a finished CLT panel: Plus or minus 3/16 inch.

C. Verify field dimensions and site conditions prior to fabrication.

D. Fabricate panels with 90-degree edges. Do not chamfer edges, unless noted otherwise.

E. Shop fabricate CLT panels to receive connections to the greatest extent possible, including cutting to length, so as to avoid field cutting, drilling, or other fabrication. Where field fabrication is required, clearly indicate field fabrication on shop drawings.

F. Mark CLT panels for identification during installation. Ensure marks will be concealed from view in the final building assembly.

G. Product labels or other markings shall not be placed on architectural appearance CLT panel surfaces.

H. Fabricate steel hardware and connections with joints neatly fitted and welded to tolerances compatible with the CLT panel fabrication. Trial fit connections in shop prior to shipping.

I. Structural steel hardware shall be prime painted. Clean surfaces to be prime painted. Remove loose rust and mill scale and splatter, slag, or flux deposits. At a minimum prepare surfaces to SSPC-SP1 “Solvent Cleaning”, and SSPC-SP 2 “Hand Tool Cleaning. Immediately after surface preparation, apply primer according to manufacturer’s written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 3 mils. Use priming methods that result in full coverage of joints, corners, edges, and surfaces.

J. Structural steel welding shall be in accordance with AWS and performed by AWS certified welders.

K. Structural steel bolt holes shall be standard size unless noted otherwise.

2.4 SHOP FINISH

A. CLT panel faces are finished as bare wood with an 80 grit sanded surface unless noted otherwise.

B. Apply end grain sealer on all perimeter and interior panel edges where end grain laminations are exposed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation, survey the construction in areas to receive CLT panels with Installer present for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install CLT panels in accordance with manufacturer's recommendations and the Installation Method Statement.

B. Install CLT panels in accordance with final reviewed shop drawings, level and plumb, and with uniform, close-fitting joints.

C. Leave CLT panels accessible to allow for complete monitoring in accordance with the Moisture Control Method Statement.

D. Provide temporary shores, guys, braces, and other supports during installation to keep the CLT panels and supporting structure secure and in alignment against environmental loads and temporary construction loads. Any failure to make proper and adequate provisions for stresses and stability during installation shall be solely the responsibility of the Contractor.

E. Handle and temporarily support CLT panels to prevent surface damage, edge damage, and other effects that might interfere with indicated finish.

F. Install connections as indicated in the structural drawing Contract Documents.

G. Provide an impervious moisture barrier at all locations where CLT panels abut concrete or masonry construction.

H. Coordinate the installation of CLT panels with size, location, and installation of building service and construction assembly components.

I. Field finish of CLT panels: As specified in Division 9.

J. Repair damaged surfaces and finishes after completing installation to the satisfaction of the Architect.

K. Site cutting, trimming, boring, or other modifications of CLT panels, other than shown on shop drawings, is not permitted without review and approval of the Architect or Structural Engineer.

3.3 PROTECTION

A. Protection of CLT panels shall be in accordance with the Moisture Control Method Statement and the manufacturer’s Product Care recommendations.

B. Do not remove protection until it no longer serves its intended purpose, including protection from moisture, sunlight, and damage from work of other trades.

C. Do not deface CLT panels.

3.4 INSTALLATION TOLERANCES

A. Overall Square: For rectangular areas where multiple CLT panels have been installed, the two corner-to-corner diagonal measurements of an area shall not deviate from each other by more than 1/2 inch or 0.25% of the length (inches) of the shortest side of the rectangle, whichever is greater.

B. Walls:

1. Plumb: Do not exceed the greater of h/500 or 3/16 inch deviation from plumb per story measured at any point along the wall. For multistory buildings, the total plumb measured at any point along wall shall not exceed the lesser of H/500 or 2 inches.
2. Position: Plus or minus 3/8 inch from theoretical at base, max.
3. Misalignment and gaps at abutted wall panel joints:

   a. Exposed: 1/8 inch, max.
   b. Concealed: 3/16 inch, max.

C. Floors and Roofs:

1. Elevation: Plus or minus 3/8 inch from theoretical, max.
2. Misalignment and gaps at abutted panel joints:

   a. Exposed: 1/8 inch, max.
   b. Concealed: 3/16 inch, max.

D. CLT and supporting structure connections used may require tighter installation tolerances than specified above. The manufacturer and installer are responsible for coordination during the shop drawings process.

3.5 FIELD QUALITY CONTROL

A. The Contractor shall keep a QA/QC log that can be made available to the Architect at any time. The QA/QC log shall include items such as but not limited to:

1. Environmental conditions at all stages, such as during fabrication, storage, transportation, installation and until building is finished.
2. Quality control log showing the actual length, thickness and width of the CLT panels. Length, width, thickness and diagonal measurement to be noted on top surface of CLT panels. Tolerances as per these specifications.
3. Site deliveries including verified load manifests with notes of damaged or missing materials and elements.
4. Material and element install log with sign off for QC on hardware/fastener installation.
5. Log of equipment used, such as but not limited to torque drills (with torque clutch) for screw installation through steel plates etc.
6. Record moisture levels of CLT in accordance with the Moisture Control Method Statement.
7. Log of any changes, modifications, damage, or repair.

3.6 DEMONSTRATION & TRAINING

A. Comply with Division 01, Section 017905 "Demonstration and Training" for general requirements of demonstration and training documentation.

B. The manufacturer's representative shall provide 'hands-on' training sessions for the Government O&M personnel.

1. Schedule as follows:

a. Classroom Instruction: Two (2) hours.
b. Field Demonstration: Four (4) hours.

C. Training shall cover the following topics:

1. Maintenance and repair including manufacturer's data within the O&M manual.
2. Inspection requirements and/or techniques with appropriate specialty tools.
3. Monitoring requirements with appropriate/specified equipment and diagnostic analysis.

END OF SECTION 061719

SECTION 061800 - GLUED-LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Framing using structural glued-laminated timber.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for dimension lumber items associated with structural glued-laminated timber.
2. Section 061300 "Heavy Timber Construction" for framing using [**timbers**] [**and**] [**round wood poles**].
3. Section 061516 "Wood Roof Decking" for glued-laminated wood roof decking.

1.3 DEFINITIONS

A. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on lumber, adhesives, fabrication, and protection.
2. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
3. For connectors. Include installation instructions.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for regional materials.>
2. <Double click to insert sustainable design text for certified wood.>
3. <Double click to insert sustainable design text for certified wood.>
4. <Double click to insert sustainable design text for laminating adhesive.>

C. Shop Drawings:

1. Show layout of structural glued-laminated timber system and full dimensions of each member.
2. Indicate species and laminating combination.
3. Include large-scale details of connections.

D. Samples: Full width and depth, 24 inches (600 mm) long, showing the range of variation to be expected in appearance of structural glued-laminated timber[**including variations due to specified treatment**].

1. Apply specified factory finish to three sides of half length of each Sample.

E. Delegated-Design Submittal: For structural glued-laminated timber and timber connectors.

F. Operations & Maintenance Manual: Provide manufacturer's maintenance and operation data for material components within this section. In addition to items specified in Division 01 Section "Systems Manual / O&M Data," include the following data:

1. Procedures and schedules for inspecting, monitoring, and repairing glue-laminated assemblies.
2. Procedures on mounting or penetrating glue-laminated units for future MEP infrastructure expansion.

1.5 INFORMATIONAL SUBMITTALS

A. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.

B. Material Certificates: For preservative-treated wood products, from manufacturer. Indicate type of preservative used and net amount of preservative retained.

C. Research/Evaluation Reports: For [**structural glued-laminated timber**] [**and**] [**timber connectors**], from ICC-ES.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: [**An AITC- or APA-EWS-licensed firm**] [**certified for chain of custody by an FSC-accredited certification body**].

B. <Double click to insert sustainable design text for manufacturer qualifications.>

C. <Double click to insert sustainable design text for vendor qualifications.>

1.7 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with provisions in AITC 111.

B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

1.8 EXTRA MATERIALS

A. Provide manufacturer's standard maintenance devices (e.g., special tools) associated with inspecting, monitoring, and torquing assembly components. Provide protective covering and labeling to facilitate storage and retrieval.

B. Provide extra materials as specified below. Extra materials shall match the products installed. Package these materials with protective covering for storage and include labels describing content:

1. Manufacturer’s CLT Repair Kits: Two (2).
2. Timber Connectors (as defined in Part 2.4): 1 percent of each type installed, but not less than one complete assembly connection.
3. Field-applied Coatings: Two (2) standard size containers of each type.

1.9 WARRANTY

A. Furnish the manufacturer’s two-year warranty that assures the glue-laminated product will be free of defects in material and workmanship from the date of substantial completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design structural glued-laminated timber and connectors.

B. Structural Performance: Structural glued-laminated timber and connectors shall withstand the effects of structural loads shown on Drawings without exceeding allowable design working stresses listed in AITC 117 or determined according to ASTM D3737 and acceptable to authorities having jurisdiction.

C. Seismic Performance: Structural glued-laminated timber and connectors shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

2.2 STRUCTURAL GLUED-LAMINATED TIMBER

A. General: Provide structural glued-laminated timber that complies with AITC A190.1 and AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.

1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
2. Provide structural glued-laminated timber made from single species.
3. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
4. Provide structural glued-laminated timber made with wet-use adhesive complying with AITC A190.1.
5. <Double click to insert sustainable design text for laminating adhesive.>

B. <Double click to insert sustainable design text for regional wood materials.>

C. <Double click to insert sustainable design text for certified wood.>

D. Species and Grades for Structural Glued-Laminated Timber: [**Alaska cedar**] [**Douglas fir-larch**] [**Southern pine**] [**Any species**] <**Insert species**> in grades needed to comply with "Performance Requirements" Article.

E. Species and Grades for Structural Glued-Laminated Timber: [**Alaska cedar**] [**Douglas fir-larch**] [**Southern pine**] [**Any species**] <**Insert species**> that complies with [**structural properties**] [**combination symbols**] [**beam stress classifications**] indicated.

F. Species and Grades for [**Beams**] [**and**] [**Purlins**]:

1. Species and Beam Stress Classification: [**Ponderosa pine, 16F-1.3E**] [**Alaska cedar, 20F-1.5E**] [**Eastern spruce, 20F-1.5E**] [**Any species, 20F-1.5E**] [**Any species, 24F-1.7E**] [**Douglas fir-larch, 24F-1.8E**] [**Southern pine, 24F-1.8E**] [**Douglas fir-larch or southern pine, 24F-1.8E**] [**Southern pine, 30F-2.1E**] <**Insert species and beam stress classification**>.
2. Lay-up: [**Balanced**] [**Either balanced or unbalanced**].
3. Species and Combination Symbol: <**Insert species and combination symbol**>.

G. Species and Grades for Arches:

1. Species and Beam Stress Classification: [**Alaska cedar, 20F-1.5E**] [**Eastern spruce, 20F-1.5E**] [**Any species, 20F-1.5E**] [**Any species, 24F-1.7E**] [**Douglas fir-larch, 24F-1.8E**] [**Southern pine, 24F-1.8E**] [**Douglas fir-larch or southern pine, 24F-1.8E**] <**Insert species and beam stress classification**>.
2. Lay-up: [**Balanced**] [**Either balanced or unbalanced**].
3. Species and Combination Symbol: [**Alaska cedar, 20F-V13 WS**] [**Douglas fir-larch, 24F-V8 WS**] [**Southern pine, 24F-V5 SP**] [**Alaska cedar, 20F-V12 WS**] [**Douglas fir-larch, 24F-V4 WS**] [**Southern pine, 24F-V3 SP**] <**Insert species and combination symbol**>.

H. Species and Grades for [**Columns**] [**and**] [**Truss Members**]:

1. Species and Combination Symbol: [**Alaska cedar, 70**] [**Douglas fir-larch, 1**] [**Douglas fir-larch, 3**] [**Southern pine, 47**] [**Southern pine, 50**] <**Insert species and combination symbol**>.

I. Appearance Grade: [**Premium**] [**Architectural**] [**Industrial**] [**Framing**], complying with AITC 110.

1. For Premium and Architectural appearance grades, fill voids as required by AITC 110.[**For Premium appearance grade, use clear wood inserts, of matching grain and color, for filling voids and knot holes more than 1/4 inch (6 mm) wide.**]

2.3 PRESERVATIVE TREATMENT

A. Preservative Treatment: Where preservative-treated structural glued-laminated timber is indicated, comply with AWPA U1, Use [**Category 1**] [**Category 2**] [**Category 3A**] [**Category 3B**] [**Category 4A**].

1. Use preservative solution without[**water repellents or**] substances that might interfere with application of indicated finishes.
2. Do not incise structural glued-laminated timber or wood used to produce structural glued-laminated timber.

B. Preservative:[**One of the following:**]

1. Oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
2. Pentachlorophenol in light petroleum solvent.
3. Copper naphthenate in a light petroleum solvent.
4. Ammoniacal zinc copper arsenate (ACZA) in a water solution.
5. Chromated copper arsenate (CCA) in a water solution.
6. Ammoniacal copper quat Type A (ACQ-C) in a water solution.
7. Propiconazole tebuconazole imidacloprid (PTI) in a water emulsion.

C. After dressing members, apply a copper naphthenate field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.5 mm).

2.4 TIMBER CONNECTORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Fabricate beam seats from [**steel**] [**stainless steel**] with [**0.239-inch (6-mm)**] [**3/16-inch (5-mm)**] [**3/8-inch (9.5-mm)**] bearing plates, 3/4-inch- (19-mm-) diameter-by-12-inch- (300-mm-) long deformed bar anchors, and 0.239-inch (6-mm) side plates.

C. Fabricate arch base shoes from [**steel**] [**stainless steel**] with 1-inch (25-mm) baseplates and 3/8-inch (9.5-mm) side plates.

D. Fabricate beam hangers from [**steel**] [**stainless steel**] with 0.179-inch (4.6-mm) stirrups and 0.239-inch (6-mm) top plates.

E. Fabricate hinge connectors from [**steel**] [**stainless steel**] with 0.179-inch (4.6-mm) side plates and [**3/4-inch (19-mm)**] [**1-inch (25-mm)**] top and bottom plates.

F. Fabricate strap ties from [**steel**] [**stainless steel**], [**2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm)**] [**3 inches (75 mm) wide by 0.239 inch (6 mm)**] thick.

G. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A668/A668M.

H. Provide bolts, 3/4 inch (19 mm) unless otherwise indicated, complying with ASTM A307, Grade A (ASTM F568M, Property Class 4.6); nuts complying with ASTM A563 (ASTM A563M); and, where indicated, flat washers.

I. Provide shear plates, [**2-5/8 inches (66.7 mm)**] [**4 inches (102 mm)**] in diameter, complying with ASTM D5933.

J. Materials: Unless otherwise indicated, fabricate from the following materials:

1. Structural-steel shapes, plates, and flat bars complying with ASTM A36/A36M.
2. Round steel bars complying with ASTM A575, Grade M 1020.
3. Hot-rolled steel sheet complying with ASTM A1011/A1011M, Structural Steel, Type SS, Grade 33.
4. Stainless steel flat bars complying with ASTM A666, [**Type 304**] [**Type 316**].
5. Stainless steel bars and shapes complying with ASTM A276, [**Type 304**] [**Type 316**].
6. Stainless steel plate, sheet, and strip complying with ASTM A240/A240M or ASTM A666, [**Type 304**] [**Type 316**].

K. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.

L. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A123/A123M or ASTM A153/A153M.

2.5 MISCELLANEOUS MATERIALS

A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.6 FABRICATION

A. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.

1. Dress exposed surfaces as needed to remove planing and surfacing marks.

B. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.

C. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.

1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

D. End-Cut Sealing: Immediately after end cutting each member to final length[**and after preservative treatment**], apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.

E. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit[**except for preservative-treated wood where treatment included a water repellent**].

2.7 FACTORY FINISHING

A. Wiped Stain Finish: Manufacturer's standard, dry-appearance, penetrating acrylic stain and sealer; oven dried and resistant to mildew and fungus.

1. Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <**Insert color**>.

B. Clear Finish: Manufacturer's standard, two-coat, clear varnish finish; resistant to mildew and fungus.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates in areas to receive structural glued-laminated timber, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.

B. Framing Built into Masonry: Provide 1/2-inch (13-mm) clearance at tops, sides, and ends of members built into masonry; bevel cut ends 3 inches (76 mm); and do not embed more than 4 inches (102 mm) unless otherwise indicated.

C. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.

D. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing[**and finishing**].

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Coat cross cuts with end sealer.
4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

   a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
   b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

E. Install timber connectors as indicated.

1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
2. Install bolts with orientation as indicated or, if not indicated, as directed by Architect.

3.3 ADJUSTING

A. Repair damaged surfaces**[and finishes]** after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect.

3.4 PROTECTION

A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.

1. Coordinate wrapping removal with finishing work. Retain wrapping where it can serve as a painting shield.
2. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

3.5 DEMONSTRATION & TRAINING

A. Comply with Division 01, Section 017905 “Demonstration and Training” for general requirements of demonstration and training documentation.

B. The manufacturer’s representative shall provide ‘hands-on’ training sessions for the Government O&M personnel.

1. Schedule as follows:

a. Classroom Instruction: Two (2) hours.
b. Field Demonstration: Four (4) hours.

C. Training shall cover the following topics:

1. Maintenance and repair including manufacturer’s data within the O&M manual.
2. Inspection requirements and/or techniques with appropriate specialty tools.
3. Monitoring requirements with appropriate/specified equipment and diagnostic analysis.

END OF SECTION 061800

SECTION 062025 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior trim.
2. Interior plywood paneling.

B. Related Requirements:

1. Section 064025 “Interior Architectural Woodwork” for cabinets and other architectural woodwork.
2. Division 09 Section “Painting and Finishing” for priming and backpriming of interior finish carpentry.

1.2 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO: Plywood with a medium-density overlay on the face.

C. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.

B. Sustainable Design Submittals:

1. Product Certificates: For materials manufactured within 100 miles (160 km) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
5. Product Data: For installation adhesives, indicating VOC content.
6. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

C. Samples for Verification:

1. For each species and cut of lumber and panel products with nonfactory-applied finish, with half of exposed surface finished; 300 sq. cm (50 sq. in.) for lumber and 200 by 250 mm (8 by 10 inches) for panels.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.

1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
2. Provide for air circulation around stacks and under coverings.

B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet-work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Regional Materials: The following wood products shall be manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

1. Interior trim.
2. Interior plywood paneling.

B. Certified Wood: The following wood products shall be certified as "FSC Pure"[or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.

1. Interior trim.
2. Interior plywood paneling.

3. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

C. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by grading agency.

D. Softwood Plywood: DOC PS 1.

E. Hardboard: ANSI A135.4.

F. MDF: ANSI A208.2, Grade 130.

2.2 FIRE-RETARDANT-TREATED WOOD MATERIALS

A. Fire-Retardant-Treated Wood Materials: Where fire-retardant-treated materials are indicated, use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of the Architectural Woodwork Standards. Do not use materials that are warped, discolored, or otherwise defective.

2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 3.2 m (10.5 feet) beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained, transparent, or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment, and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

2.3 INTERIOR TRIM

A. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

1. Species: Honduras Mahogany or other hardwood with similar weight, moisture content, and hardness, and approved by the Project Director/COR.
2. Weight: Air Dried, 30-52 pounds per cubic foot, minimum.
3. Moisture Content: 12 percent.
4. Janka Hardness Test: 2200 minimum.
5. Finger Jointing: Not allowed.
6. Gluing for Width: Use for lumber trim wider than 150 mm (6 inches).
7. Veneered Material: Not allowed.
8. Face Surface: [Surfaced (smooth)][Saw textured].
9. Matching: Selected for compatible grain and color.

B. Lumber Trim for Opaque Finish (Painted Finish): Finished lumber (S4S), either finger-jointed or solid lumber, of one of the following species and grades:

1. Grade Finish or 1 Common eastern white pine; NELMA or NLGA.
2. Grade 1 Common spruce-pine-fir; NELMA, NLGA, WCLIB, or WWPA.
3. Grade A Finish alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, tupelo, or yellow poplar; NHLA.

C. Moldings: Made to patterns included in WMMPA WM 7. Wood moldings made from kiln-dried stock and graded under WMMPA WM 4.

1. Moldings for Transparent Finish (Stain Finish): Honduras Mahogany or other hardwood with the following properties and approved by the Project Director/COR:

   a. Weight: Air Dried, 30-52 pounds per cubic foot, minimum.
   b. Moisture Content: 12 percent.
   c. Janka Hardness Test: 2200 minimum.

2. Moldings for Opaque Finish (Painted): P-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine.
3. Molding shapes as indicated on Drawings.

2.4 PANELING

A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1.

1. Face Veneer Species and Cut: Honduras Mahogany, plain sawn or sliced cuts (Basis-of-Design), or other Semi-open grain hardwood with similar weight, moisture content, and hardness: African Mahogany, plain sawn or ribbon striped cut; African Rosewood, plain sawn; Brazilian Cherry (Jatoba Heartwood), plain sawn; Brazilian Walnut (Ipe), plain sawn; or Teak, plain sawn or sliced cuts.
2. Veneer Matching: [Random match] [Selected for similar color and grain].
3. Backing Veneer Species: Any hardwood compatible with face species.
4. Construction: Veneer core.
5. Thickness: 4 mm (5/32 inch).
6. Panel Size: [**1219 by 2438 mm (48 by 96 inches)**] [**1219 by 3048 mm (48 by 120 inches)**].
7. Panel Size: [1200 by 2400 mm] [1200 by 3000 mm].
8. Glue Bond: Type II (interior).
9. Finish: Class I.
10. ASTM E 84: Flame Spread 25 maximum, Smoke Developed 450 maximum

2.5 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

B. Low-Emitting Materials: Adhesives shall comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.

1. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2. Adhesives shall have a VOC content of **[30]** <**Insert value**> g/L or less.

D. Paneling Adhesive: Comply with paneling manufacturer's written instructions for adhesives.

1. Adhesives shall have a VOC content of **[50]** <**Insert value**> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Multipurpose Construction Adhesive: Formulation, complying with ASTM D 3498, that is recommended for indicated use by adhesive manufacturer.

1. Adhesives shall have a VOC content of **[70]** <**Insert value**> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 FABRICATION

A. Back out or kerf backs of the following members, except those with ends exposed in finished work:

1. Interior standing and running trim, except shoe and crown molds.
2. Wood-board paneling.

B. Ease edges of lumber less than 25 mm (1 inch) in nominal thickness to 1.5-mm (1/16-inch) radius and edges of lumber 25 mm (1 inch) or more in nominal thickness to 3-mm (1/8-inch) radius.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

A. Do not use materials that are unsound; warped; improperly treated or finished; inadequately seasoned; too small to fabricate with proper jointing arrangements; or with defective surfaces, sizes, or patterns.

B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials.

1. Use concealed shims where necessary for alignment.
2. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
3. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
4. Install to tolerance of 3 mm in 2438 mm (1/8 inch in 96 inches) for level and plumb. Install adjoining interior finish carpentry with 0.8-mm (1/32-inch) maximum offset for flush installation and 1.5-mm (1/16-inch) maximum offset for reveal installation.
5. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 STANDING AND RUNNING TRIM INSTALLATION

A. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available.

1. Do not use pieces less than 610 mm (24 inches) long, except where necessary.
2. Stagger joints in adjacent and related standing and running trim.
3. Cope at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint.
4. Use scarf joints for end-to-end joints.
5. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
6. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
7. Install trim after gypsum-board joint finishing operations are completed.
8. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting.
9. Fasten to prevent movement or warping.
10. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 PANELING INSTALLATION

A. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels.

1. Leave 6-mm (1/4-inch) gap to be covered with trim at top, bottom, and openings.
2. Install with uniform tight joints between panels.
3. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners.
4. Space fasteners and adhesive as recommended by panel manufacturer.
5. Conceal fasteners to greatest practical extent.

3.6 ADJUSTING

A. Replace interior finish carpentry that is damaged or does not comply with requirements.

1. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

B. Adjust joinery for uniform appearance.

3.7 CLEANING

A. Clean interior finish carpentry on exposed and semi-exposed surfaces.

B. Restore damaged or soiled areas and touch up factory-applied finishes if any.

3.8 PROTECTION

A. Protect installed products from damage from weather and other causes during construction.

B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062025

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standing and running trim.
2. Closet and utility shelving.
3. Interior frames and jambs.
4. Wood-veneer-faced architectural cabinets.
5. Plastic-laminate-faced architectural cabinets.
6. Flush wood paneling and wainscots.
7. Plastic-laminate countertops.
8. Stone countertops.
9. Solid surfacing countertops.
10. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
11. Shop finishing of interior architectural woodwork.

B. Material Index / Material Codes Include:

1. **WDG-[##] or [WDB-[##] <INTERIOR STANDING AND RUNNING TRIM .>**
2. **WDG-[##] <INTERIOR FRAMES AND JAMBS.>**
3. **WDG-[##] <WOOD CABINETS.>**
4. **PLG-[##] <PLASTIC-LAMINATE-CLAD CABINETS.>**
5. **WDW-[##] <FLUSH WOOD PANELING AND WAINSCOTS.>**
6. **STG-[##] <STONE COUNTERTOPS.>**
7. **SOG-[##] <SOLID SURFACE COUNTERTOPS.>**

C. Related Requirements:

1. **[Division 06 Section "Rough Carpentry"] [Division 06 Section "Miscellaneous Rough Carpentry"]** for wood furring, blocking, shims, and hanging strips required for installing interior architectural woodwork that are concealed within other construction before interior architectural woodwork installation.
2. Division 06 Section on "Interior Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.
3. Division 09 Section “Painting and Finishing” for priming and backpriming of interior finish carpentry.

1.2 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO: Plywood with a medium-density overlay on the face.

C. PVC: Polyvinyl chloride.

1.3 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that interior architectural woodwork can be supported and installed as indicated.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Cabinet hardware and accessories.
2. Handrail brackets.
3. Anchors.
4. Adhesives.
5. Finishing materials and processes.
6. Wood-Preservative Treatment:

    a. Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
    b. Indicate type of preservative used and net amount of preservative retained.
    c. Include chemical-treatment manufacturer's written instructions for finishing treated material and manufacturer's written warranty.

7. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
8. Waterborne Treatments: For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For installation adhesives, indicating VOC content.
3. Product Certificates: For materials manufactured within 100 miles (160 km) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.

4. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
5. Chain-of-Custody Qualification Data: For manufacturer and vendor.
6. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Include the following:

   a. Dimensioned plans, elevations, and sections.
   b. Attachment details.

2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
5. Show location/size/type of woodwork hardware and cutouts for plumbing/electrical fixtures.
6. Apply **[AWI Quality Certification] [WI Certified Compliance]** Program label to Shop Drawings.
7. Show direction of veining, grain, or other directional patterns for countertops.
8. Show locations and details of countertop joints.

D. Samples: For each exposed product, cabinet hardware exposed in the finished work, and for each shop-applied color and finish specified.

1. Lumber and Panel Products with Transparent Finish: Not less than 300 mm (12 inches) long by full width by full depth sections, for each species and cut, finished on one side and one edge.

2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished interior architectural woodwork.

3. Lumber and Panel Products with Shop-Applied Opaque Finish: Not less than 300 mm (12 inches) long by full width by full depth sections for lumber and 300 by 300 mm (12 by 12 inches) for panels, for each finish system and color.

   a. Finish one-half of exposed surface.

4. Plastic laminate: Submit minimum 50 mm by 75 mm (2 inch by 3 inch) samples of manufacturer's full range of standard color and texture samples for selection by COR, based on input from the A/E of Record.
5. Cabinetry and millwork items: Submit samples showing construction, finish, color and gloss for the following:

a. Finished veneer wood: 2 adjacent finished edges, 300 mm x 300 mm (12 inch x 12 inch) for each veneer required.
b. Plastic laminate cabinet door section: 300 mm x 300 mm x 19 mm (12 inch x 12 inch x 3/4 inch) with finger pull.
c. Finished solid wood: 19 mm x 150 mm x 300 mm (3/4 inch x 6 inch x 12 inch) for each type of wood.
d. Plastic laminate top and edge with finished edges: 300 mm x 300 mm (12 inch x 12 inch) x depth of fascia.

6. Submit samples of each type of stone species and finish for stone countertops indicating anticipated range of stone color and texture in finished Work.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[architectural woodwork manufacturer] [and] [Installer]**.

B. Product Certificates: For the following:

1. Composite wood and agrifiber products.
2. Adhesives.

C. Evaluation Reports: For [**preservative-treated**] [**and**] **[fire-retardant-treated]** wood materials, from ICC-ES.

1.7 CLOSEOUT SUBMITTLAS

A. Quality Standard Compliance Certificates: **[AWI Quality Certification Program] [WI Certified Compliance Program]** certificates.

B. Maintenance Data: For countertop materials to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.8 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in **[AWI's Quality Certification Program] [WI's Certified Compliance Program]**.

2. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body or other LEED recognized equivalent certification body for Certified Wood Pilot Alternative Compliance Path (ACP) to achieve green building credits.

3. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body or other LEED recognized equivalent certification body for Certified Wood Pilot Alternative Compliance Path (ACP) to achieve green building credits.

B. Installer Qualifications: [Manufacturer of products] [and] [Licensed participant in AWI's Quality Certification Program] [Licensed participant in WI's Certified Compliance Program].

1. If a local alternate quality control program is proposed, it will be at the discretion of the Project Director/COR to use that program.
2. Installer Qualifications: Not less than 5 years documented successful experience with work comparable to Work of this Project.

C. Mockups: Build sample installations to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of **[typical interior architectural woodwork as shown on Drawings]** <**Insert description**>.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR specifically approves such deviations by Change Order, based on input from the A/E of Record.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Architectural Woodwork Standards, Section 2.

B. Do not deliver interior architectural woodwork until painting and similar finish operations that might damage woodwork have been completed in installation areas.

C. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1. Handle and store fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of the construction period.

B. Field Measurements: Where interior architectural woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction and indicate measurements on Shop Drawings.

C. Established Dimensions: Where interior architectural woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

D. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.11 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that architectural woodwork can be supported and installed as indicated.

B. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Frames: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

2.2 ARCHITECTURAL WOODWORK, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

1. The Contract Documents contain requirements that are more stringent than the Architectural Woodwork Standards. Comply with Contract Documents and Architectural Woodwork Standards.

B. Regional Materials: Wood products shall be manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

C. Certified Wood: Wood products shall be certified as "FSC Pure"**[or "FSC Mixed Credit"]** according to FSC STD-01-001 and FSC STD-40-004, or other LEED recognized equivalent certification body for Certified Wood Pilot Alternative Compliance Path (ACP) to achieve green building credits.

1. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

D. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by grading agency.

E. Softwood Plywood: DOC PS 1.

F. Hardboard: ANSI A135.4.

G. MDF: ANSI A208.2, Grade 130.

H. Particleboard: ANSI A208.1, **[Grade M-2] [Grade M-2-Exterior Glue]**.

I. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

1. Color: **[White] [Black] [Gray] [As approved by the Project Director/COR from manufacturer's full range] <Insert color>**.

2.3 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH **[WDG-[##] OR [WDB-[##]]**

A. Architectural Woodwork Standards Grade: Custom and Premium, as indicated.

B. Hardwood Lumber:

1. Wood Species and Cut: Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.

2. Moisture:

   a. Wood Moisture Content: [**5 to 10] [8 to 13] [4 to 9]** percent.
   b. Finger Jointing: Not allowed.
   c. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.

3. For trim items**[other than base]** wider than available lumber, use veneered construction. Do not glue for width.

   a. For veneered base, use hardwood lumber core, glued for width.

4. For base wider than available lumber, glue for width. Do not use veneered construction.
5. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.

2.4 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH **[WDG-[##] OR [WDB-[##]]**

A. Architectural Woodwork Standards Grade: Custom.

1. Wood Species: Any closed-grain hardwood.
2. Wood Moisture Content: **[5 to 10] [8 to 13] [4 to 9]** percent.
3. Finger Jointing: **[Allowed] [Not allowed]**.

2.5 CLOSET AND UTILITY SHELVING

A. Architectural Woodwork Standards Grade: Custom.

B. Shelf Material: 19-mm (3/4-inch) [**solid lumber for transparent finish**] [**solid lumber for opaque finish**] [**plastic-laminate-clad panel product with plastic-laminate-clad edge**].

C. Cleats: 19-mm (3/4-inch) solid lumber.

D. Wood Species: Match species indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.

2.6 INTERIOR FRAMES AND JAMBS FOR TRANSPARENT FINISH **[WDG-[##]]**

A. Architectural Woodwork Standards Grade: Custom and Premium, as indicated.

B. Wood Species and Cut: Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.

1. Wood Moisture Content: **[5 to 10] [8 to 13] [4 to 9]** percent.
2. Provide split species on frames and jambs that face areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.

C. For frames or jambs wider than available lumber, use veneered construction. Do not glue for width.

1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 76 mm (3 inches) wide.

D. Fire-Rated Interior Frames and Jambs: Products fabricated from fire-retardant particleboard or fire-retardant MDF with veneered exposed surfaces and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1. Fire Rating: 20 minutes.

2.7 INTERIOR FRAMES AND JAMBS FOR OPAQUE FINISH **[WDG-[##]]**

A. Architectural Woodwork Standards Grade: Custom.

B. Wood Species: Any closed-grain hardwood.

1. Wood Moisture Content: **[5 to 10] [8 to 13] [4 to 9]** percent.

C. Fire-Rated Interior Frames and Jambs: Products fabricated from fire-retardant particleboard with veneered exposed surfaces or fire-retardant MDF and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing in accordance with NFPA 252.

1. Fire Rating: 20 minutes.

2.8 WOOD CABINETS FOR TRANSPARENT FINISH **[WDG-[##]]**

A. Architectural Woodwork Standards Grade: Custom and Premium, as indicated.

B. Type of Construction: **[Frameless] [Face frame]**.

C. Door and Drawer-Front Style: Flush overlay.

D. Wood for Exposed Surfaces

1. Species: **[Red oak] [White oak] [White ash] [White birch]** <**Insert species**>.

2. Cut: **[Plain sliced/plain sawn] [Rift cut/rift sawn] [Quarter cut/quarter sawn]**.
3. Grain Direction: **[Vertically for drawer fronts, doors, and fixed panels] [Horizontally for drawer fronts, doors, and fixed panels] [Vertically for doors and fixed panels, horizontally for drawer fronts] [As indicated on Drawings]**.
4. Matching of Veneer Leaves: **[Book] [Slip] [Random]**.
5. Veneer Matching within Panel Face: Center-balance match.
6. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.

E. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies**: [Same species and cut indicated for exposed surfaces] [Thermally fused laminate panels] [Compatible species to that indicated for exposed surfaces, stained to match] <Insert requirements>**.

   a. Edges of **Thermally Fused Laminate Panel** Shelves: PVC or polyester edge banding.

2. Drawer Subfronts, Backs, and Sides: **[Solid-hardwood lumber, same species indicated for exposed surfaces] [Solid-hardwood lumber, stained to match species indicated for exposed surfaces] [Solid-hardwood lumber] [Thermally fused laminate panels with PVC or polyester edge banding] <Insert requirements>**.
3. Drawer Bottoms: **[Hardwood plywood] [Thermally fused laminate panels] <Insert requirements>**.

F. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

2.9 WOOD CABINETS FOR OPAQUE FINISH **[WDG-[##]]**

A. Architectural Woodwork Standards Grade: Custom.

B. Type of Construction: **[Frameless] [Face frame]**.

C. Door and Drawer-Front Style: Flush overlay.

D. Species for Exposed Lumber Surfaces: Any closed-grain hardwood.

E. Panel Product for Exposed Surfaces: MDF.

F. Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: **[Match materials indicated for exposed surfaces] [Thermally fused laminate panels] <Insert requirements>**.

a. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.

2. Drawer Sides and Backs: **[Solid-hardwood lumber] [Thermally fused laminate panels with PVC or polyester edge banding] <Insert requirements>**.
3. Drawer Bottoms: **[Hardwood plywood] [Thermally fused laminate panels] <Insert requirements>**.

G. **[Dust Panels: 6.4-mm (1/4-inch) plywood or tempered hardboard above compartments and drawers unless located directly under tops.]**

H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

2.10 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS **[PLG-[##]]**

A. Architectural Woodwork Standards Grade: Custom.

B. Type of Construction: **[Frameless] [Face frame]**.

C. Door and Drawer-Front Style: Flush overlay.

D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Abet Laminati Inc.
b. Formica Corporation.
c. Lamin-Art, Inc.
d. Pionite; a Panolam Industries International, Inc. brand.
e. Wilsonart LLC.

E. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.
2. Vertical Surfaces: Grade HGS.
3. Edges: Grade HGS.
4. Pattern Direction: Vertically for doors and fixed panels, horizontally for drawer fronts.

F. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Edges of Plastic-Laminate Shelves: **[PVC tape, 0.460-mm (0.018-inch) minimum thickness, matching laminate in color, pattern, and finish] [PVC T-mold matching laminate in color, pattern, and finish] [PVC edge banding, 3 mm (0.12 inch) thick, matching laminate in color, pattern, and finish]**.

3. Edges of **Thermally Fused Laminate Panel** Shelves: PVC or polyester edge banding.

4. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
5. Drawer Sides and Backs: **[Solid-hardwood lumber] [Thermally fused laminate panels with PVC or polyester edge banding]**.
6. Drawer Bottoms: **[Hardwood plywood] [Thermally fused laminate panels]**.

G. **[Dust Panels: 6.4-mm (1/4-inch) plywood or tempered hardboard above compartments and drawers unless located directly under tops.]**

H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. Match Project Director/COR's sample.

2.11 FLUSH WOOD PANELING AND WAINSCOTS **[WDW-[##]]**

A. Grade: Custom and Premium, as indicated.

B. Wood Species and Cut: **[White oak, rift sliced] [Select white ash, plain sliced] [Sycamore, plain sliced] [Cherry, plain sliced] [Butternut, plain sliced] [Avodire, quarter sliced]** <Insert species and cut>.

C. Veneer Matching Method:

1. Adjacent Veneer Leaves: Slip match.
2. Within Panel Face: Balance match.
3. Adjacent Veneer Leaves and within Panel Face: Slip, center-balance, or book match.

D. Panel-Matching Method:

1. Premanufactured panel sets selectively reduced in width within each separate area.

E. Vertical Panel-Matching Method: Architectural end slip match; veneer leaves are individually slip matched from lower panels to upper panels.

F. Panel Core Construction: **[Hardwood veneer-core plywood] [Fire-retardant particleboard or fire-retardant MDF]**.

1. Thickness: [**19 mm (3/4 inch)**] [As indicated on Drawings].

G. Exposed Panel Edges: **[Inset solid-wood or wood-veneer matching faces] [Legs of metal channels forming reveals] [Applied solid-wood banding 18 mm (11/16 inch) thick by depth of panels] [Applied bronze flat bars 1.6 mm (1/16 inch) thick by depth of panels] <Insert description>**.

H. Panel Reveals: **[Matte black plastic laminate] [Bronze sheet] [Stainless-steel sheet] [Bronze channels, 25.4 by 25.4 by 3.2 mm (1 by 1 by 1/8 inch) thick] [Stainless-steel channels, 25.4 by 25.4 by 1.6 mm (1 by 1 by 1/16 inch) thick] <Insert description>**.

I. Fire-Retardant-Treated Paneling: Panels shall consist of wood-veneer and fire-retardant particleboard or fire-retardant, medium-density fiberboard (MDF). Panels shall have a flame-spread index of **[25] [75]** or less and a smoke-developed index of 450 or less per ASTM E 84, and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.

J. Assemble panels by gluing and concealed fastening.

2.12 PLASTIC-LAMINATE-CLAD COUNTERTOPS **[PLG-[##]]**

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.

B. Grade: Custom.

C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Abet Laminati Inc.
b. Formica Corporation.
c. Lamin-Art, Inc.
d. Pionite; a Panolam Industries International, Inc. brand.
e. Wilsonart LLC.

D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. Match Project Director/COR's sample.

E. Edge Treatment: Same as laminate cladding on horizontal surfaces.

F. Core Material: Exterior-grade plywood.

G. Core Thickness: **[19 mm (3/4 inch)] [29 mm (1-1/8 inch)]**.

1. Build up countertop thickness to 38 mm (1-1/2 inches) at front, back, and ends with additional layers of core material laminated to top.

H. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

2.13 GRANITE COUNTERTOPS **[STG-[##]]**

A. Material Standard: Comply with ASTM C 615/C 615M.

B. Description: Uniform, **[fine] [medium]**-grained, **[white] [pink] [gray] [black]** <**Insert color**> stone**[without veining]**.

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Cut: **[Vein] [Fleuri]**.

E. Cut stone from contiguous, matched slabs in which natural markings occur.

F. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.14 MARBLE COUNTERTOPS **[STG-[##]]**

A. Material Standard: Comply with ASTM C503/C503M**[, Classification I Calcite] [, Classification II Dolomite] [, Group A] [, Group B] [, Group C] [, Group D]**.

B. Description: Uniform, fine- to medium-grained, **[white] <Insert color>** stone with only slight veining.

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the fol-lowing]**:

1. **<Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers>**.

D. Cut: [Vein] [Fleuri].

E. Cut stone from contiguous, matched slabs in which natural markings occur.

F. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.15 OTHER STONE COUNTERTOPS **[STG-[##]]**

A. Material Standards:

1. Maximum Absorption per ASTM C97/C97M: <**Insert value**>.
2. Minimum Compressive Strength per ASTM C170/C170M: <**Insert value**>.
3. Minimum Flexural Strength per ASTM C880/C880M: <**Insert value**>.

B. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

C. Cut stone from contiguous, matched slabs in which natural markings occur.

D. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.16 STONE ACCESSORIES:

A. Water-Cleanable Epoxy Adhesive: ANSI A118.3. Use only adhesive formulated for stone and recommended by manufacturer for this application.

B. Sealant for Countertops: Single-component, neutral-curing silicone sealant. Use sealants which will not stain stone.

C. Stone Cleaner: Cleaner specifically formulated for stone types, finish, and application, as recommended by stone producer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

D. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application.

2.17 SOLID SURFACE COUNTERTOP MATERIALS **[SOG-[##]]**

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

1. Type: Provide Standard type unless Special Purpose type is indicated.
2. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
3. Colors and Patterns: Match Project Director/COR's samples.

2.18 HARDWOOD SHEET MATERIALS

A. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.

1. Recycled Content of MDF and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

2. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.
3. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
4. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
5. Softwood Plywood: DOC PS 1, medium-density overlay.
6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.19 PRESERVATIVE-TREATED-WOOD MATERIALS

A. Preservative-Treated-Wood Materials: Provide with water-repellent preservative treatment complying with AWPA N1 (dip, spray, flood, or vacuum-pressure treatment).

B. Extent of Preservative-Treated Wood Materials: Treat **[interior architectural woodwork in contact with concrete or masonry] <Insert requirements>**.

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category **[UC1] [UC2]**.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 18 percent, respectively.
2. Preservative Chemicals: Acceptable to the Project Director/COR**[and containing no arsenic or chromium]**.
3. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
4. Do not use material that is warped or does not comply with requirements for untreated material.
5. Mark lumber with treatment-quality mark of an inspection agency acceptable to the Project Director/COR.

a. For exposed lumber indicated to receive a stained or natural finish, **[mark end or back of each piece] [or] [omit marking and provide certificates of treatment compliance issued by inspection agency]**.

6. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

a. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

2.20 FIRE-RETARDANT-TREATED WOOD MATERIALS

A. Fire-Retardant-Treated Wood Materials: Where fire-retardant-treated materials are indicated, use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of the Architectural Woodwork Standards. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 3.2 m (10.5 feet) beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained, transparent, or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment, and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture, to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less according to ASTM E 84.

1. For panels 19 mm (3/4 inch) thick and less, comply with ANSI A208.1 for Grade M-2, except for the following minimum properties: modulus of rupture, 11 MPa (1600 psi); modulus of elasticity, 2070 MPa (300,000 psi); internal bond, 550 kPa (80 psi); and screw-holding capacity on face and edge, 1100 and 1000 N (250 and 225 lbf), respectively.
2. For panels 20 to 32 mm (13/16 to 1-1/4 inches) thick, comply with ANSI A208.1 for Grade M-1, except for the following minimum properties: modulus of rupture, 9 MPa (1300 psi); modulus of elasticity, 1720 MPa (250,000 psi); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 1100 and 780 N (250 and 175 lbf), respectively.

D. Fire-Retardant Fiberboard: Medium-density fiberboard (MDF) panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture, to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less according to ASTM E 84.

2.21 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Division 08 Section "Door Hardware."

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. **[Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer name, product name or designation> or comparable product by one of the following:]**

   a. Accuride International.
   b. Blum, Julius & Co., Inc.
   c. CompX International, Inc.
   d. Knape & Vogt Manufacturing Company.

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 135 170 degrees of opening, self-closing.

C. [Butt Hinges: (70-mm), five-knuckle steel hinges made from (2.4-mm-) thick metal, and as follows:

1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.]

D. Back-Mounted Pulls: BHMA A156.9, B02011.

E. **Tab Pulls: Back mounted, solid metal, 102 mm (4 inch) long.**

F. **[Wire Pulls: Back mounted, solid metal, 102 mm (4 inch) long, 63.5 mm (2 1/2 inches) deep, and 8 mm (5/16 inch) in diameter.]**

G. Catches: Magnetic catches, BHMA A156.9, B03141 Push-in magnetic catches, BHMA A156.9, B03131 Roller catches, BHMA A156.9, B03071 Ball friction catches, BHMA A156.9, B03013.

H. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081 BHMA A156.9, B04102; with shelf brackets, B04112.

I. Shelf Rests: BHMA A156.9, B04013; **[metal] [plastic] [two-pin plastic with shelf hold-down clip]**.

J. Drawer Slides: BHMA A156.9.

1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.

a. Type: Full Partial extension.
b. Material: Zinc-plated Epoxy-coated steel with polymer rollers.

2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full full-overtravel-extension type; zinc-plated-steel, ball-bearing slides.
3. For drawers not more than (75 mm) high and not more than (600 mm) wide, provide **[Grade 2] [Grade 1]**.
4. For drawers more than (75 mm) high, but not more than (150 mm) high and not more than (600 mm) wide, provide **[Grade 1] [Grade 1HD-100]**.
5. For drawers more than (150 mm) high or more than (600 mm) wide, provide **[Grade 1HD-100] [Grade 1HD-200]**.
6. For trash bins not more than (500 mm) high and (400 mm) wide, provide **[Grade 1HD-100] [Grade 1HD-200]**.

K. Slides for Sliding Glass Doors: BHMA A156.9, B07063; **[plastic] [aluminum]**.

L. Door Locks: BHMA A156.11, E07121.

M. Drawer Locks: BHMA A156.11, E07041.

N. Door and Drawer Silencers: BHMA A156.16, L03011.

O. Grommets for Cable Passage: (51-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Color: **[Brown] [Black] <Insert color>**.

P. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.

Q. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.22 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Nailers: **[Softwood or hardwood lumber] [Fire-retardant-treated softwood lumber]**, kiln-dried to less than 15 percent moisture content.

1. Preservative Treatment: Provide softwood lumber treated by pressure process, AWPA U1; Use Category UC3b.

a. Provide **[where indicated] [where in contact with concrete or masonry] <Insert requirements>.**
b. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
c. Preservative Chemicals: Acceptable to the Project Director/COR **[and containing no arsenic or chromium]**.
d. Mark lumber with treatment quality mark of an inspection agency acceptable to the Project Director/COR.

2. Fire-Retardant Treatment: Complying with requirements; provide **[where indicated]** <**Insert requirements**>.

B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.

C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.

1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

D. Low-Emitting Materials: Adhesives shall comply with testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

F. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.

1. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2. Adhesives shall have a VOC content of **[30]** <**Insert value**> g/L or less.

G. Paneling Adhesive: Comply with paneling manufacturer's written instructions for adhesives.

1. Adhesives shall have a VOC content of **[50]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Multipurpose Construction Adhesive: Formulation, complying with ASTM D 3498, that is recommended for indicated use by adhesive manufacturer.

1. Adhesives shall have a VOC content of **[70]** <**Insert value**> g/L or less.
2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.23 FABRICATION, GENERAL

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

A. Back out or kerf backs of the following members, except those with ends exposed in finished work:

1. Interior standing and running trim, except shoe and crown molds.
2. Wood-board paneling.

B. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.

1. Ease edges to radius indicated for the following:

a. Edges of Solid-Wood (Lumber) Members: 1.5 mm (1/16 inch) unless otherwise indicated.

b. Edges of Rails and Similar Members More Than 19 mm (3/4 Inch) Thick: 3 mm (1/8 inch).

C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.

1. Disassemble components only as necessary for shipment and installation.
2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
3. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.

a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.24 STONE FABRICATION

A. General:

1. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that may impair structural integrity, function, or appearance.
2. Grade and mark stone for final locations to produce assembled countertop units with an overall uniform appearance.
3. Fabricate stone countertops in sizes and shapes required to comply with requirements indicated.

   a. Clean sawed backs of stones to remove rust stains and iron particles.
   b. Dress joints straight and at right angle to face unless otherwise indicated.
   c. Cut and drill sinkages and holes in stone for anchors, supports, and attachments.
   d. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
   e. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile to produce uniform shape throughout entire length of edge and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units. Form corners of molded edges as indicated with outside corners slightly eased unless otherwise indicated.
   f. Finish exposed faces of stone to comply with requirements indicated for finish of each stone type required and to match approved Samples and mockups. Provide matching finish on exposed edges of countertops, splashes, and cutouts.

4. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

B. Countertop Fabrication:

1. Nominal Thickness: 30 mm (1-3/16 inch).
2. Edge: Straight, slightly eased at top.
3. Splashes: 20 mm (13/16 inch) thick backsplashes and side splashes.
4. Joints: Fabricate countertops in sections for joining in field**[, with joints at locations indicated]**.

   a. Joint Locations: Not within 450 mm (18 inches) of a sink or cooktop and not where a countertop section less than 900 mm (36 inches) long may result, unless unavoidable.
   b. Joint Type: Bonded, 0.8 mm (1/32 inch) or less in width.

5. Cutouts and Holes:

   a. Undercounter Fixtures: Make cutouts in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

      1) Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 5 mm (3/16 inch) into fixture opening.

b. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts, and drill holes at corners of cutout locations.
c. Fittings: Drill countertops in shop for plumbing fittings, counter-mounted soap dispensers, and similar items.

2.25 SOLID SURFACING COUNTERTOPS FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Custom.

B. Solid-Surfacing-Material Thickness: As indicated in the drawings.

C. Edge: Straight, slightly eased at top.

D. Splashes: 13 mm (1/2 inch) thick backsplashes and side splashes.

E. Fabricate tops in one piece with shop-applied backsplashes and edges, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

1. Install integral sink bowls in countertops in shop.

F. Joints: Fabricate countertops in sections for joining in field**[, with joints at locations indicated]**.

1. Joint Locations: Not within 450 mm (18 inches) of a sink or cooktop and not where a countertop section less than 900 mm (36 inches) long may result, unless unavoidable.

G. Cutouts and Holes:

1. Undercounter Fixtures: Make cutouts in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
2. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts, and drill holes at corners of cutout locations.
3. Fittings: Drill countertops in shop for plumbing fittings, counter-mounted soap dispensers, and similar items.

2.26 SHOP FINISHING

A. Finish interior architectural woodwork as specified in this section at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.

B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.

1. Priming: Apply one coat of primer, compatible with finish coats, to all surfaces of painted woodwork. Concealed surfaces of plastic-laminate-clad woodwork do not require priming when surfaced with plastic laminate, backing paper, or thermoset decorative overlay.
2. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.

C. Transparent Finish:

1. Architectural Woodwork Standards Grade: Same as item to be finished.

2. Finish: System - 1, Lacquer, Nitrocellulose.
3. Finish: System - 5, Varnish, Conversion.
4. Finish: System - 11, Polyurethane, Catalyzed.
5. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
6. Staining: Match approved sample for color.

7. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.

8. Filled Finish for Open-Grain Woods:**[After staining, apply wash-coat sealer and allow to dry.]** Apply paste wood filler and wipe off excess. Tint filler to match stained wood.

9. Sheen: Satin, 31-45 or Semigloss, 46-60 gloss units measured on 60-degree gloss meter according to ASTM D 523.

D. Opaque Finish:

1. Architectural Woodworking Standards Grade: Same as item to be finished.
2. Finish: System - 1, Lacquer, Nitrocellulose.
3. Color: Match Project Director/COR's sample.
4. Sheen: Satin, 31-45 or Semigloss, 46-60 gloss units measured on 60-degree gloss meter according to ASTM D 523.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.

B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.3 INSTALLATION

A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.

B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.

C. Install interior architectural woodwork level, plumb, true in line, and without distortion.

1. Shim as required with concealed shims.
2. Install level and plumb to a tolerance of 3 mm in 2400 mm (1/8 inch in 96 inches).

D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes in accordance with AWPA M4.

F. Fire-Retardant-Treated Wood: Install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

G. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.

1. Secure with countersunk, concealed fasteners and blind nailing.
2. Use fine finishing nails**[or finishing screws]** for exposed fastening, countersunk and filled flush with interior architectural woodwork.
3. For shop-finished items, use filler matching finish of items being installed.

H. Cabinets:

1. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
2. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

3. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
4. Install cabinets level, plumb, and true in line to a tolerance of 3 mm in 2400 mm (1/8 inch in 96 inches) using concealed shims.

    a. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
    b. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
    c. Fasten wall cabinets through back, near top and bottom, and at ends not more than 400 mm (16 inches) o.c. with **[No. 10 wafer-head screws sized for not less than 38-mm (1-1/2-inch) penetration into wood framing, blocking, or hanging strips] [No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish] [toggle bolts through metal backing or metal framing behind wall finish]**.

I. Paneling:

1. Install paneling level, plumb, true in line, and without distortion. Shim as required with concealed shims. Install level and plumb to a tolerance of 3 mm in 2400 mm (1/8 inch in 96 inches). Install with no more than 1.6 mm in 2400-mm (1/16 inch in 96-inch) vertical cup or bow and 3 mm in 2400-mm (1/8 inch in 96-inch) horizontal variation from a true plane.

    a. For flush paneling with revealed joints, install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding **[0.8 mm (1/32 inch)] [1.5 mm (1/16 inch)]**.

2. Anchor paneling to supporting substrate with **[concealed panel-hanger clips] [splined connection strips] [blind nailing]**.

    a. Do not use face fastening unless **[covered by trim] [otherwise indicated]**.

J. Standing and Running Trim:

1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
2. Do not use pieces less than **[900 mm (36 inches)] [1500 mm (60 inches)] [2400 mm (96 inches)]** long, except where shorter single-length pieces are necessary.
3. Scarf running joints and stagger in adjacent and related members.
4. Fill gaps, if any, between top of base and wall with **[plastic wood filler; sand smooth; and finish same as wood base if finished] [latex sealant, painted to match wall]**.
5. Install standing and running trim with no more variation from a straight line than 3 mm in 2400 mm (1/8 inch in 96 inches).

K. Plastic-Laminate-Faced Countertops:

1. Grade: Install countertops to comply with same grade as item to be installed.
2. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

    a. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

3. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.

    a. Secure field joints in countertops with concealed clamping devices located within 150 mm (6 inches) of front and back edges and at intervals not exceeding 600 mm (24 inches). Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

4. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
5. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
6. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 3-mm-in-2400-mm (1/8-inch-in-96-inches) variation from a straight, level plane.
7. Secure backsplashes **[to tops with concealed metal brackets at 400 mm (16 inches) o.c.] [and] [to walls with adhesive].**
8. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

L. Stone Countertops:

1. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
2. Install countertops over subtops with full spread of water-cleanable epoxy adhesive.
3. Install countertops by adhering to supports with water-cleanable epoxy adhesive.

4. **[Do not cut stone in field unless otherwise indicated. If stone countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.]**
5. **[Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight, true, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.]**
6. Set stone to comply with requirements indicated. Shim and adjust stone to locations indicated, with uniform joints of widths indicated and with edges and faces aligned

according to established relationships and indicated tolerances**.[Install anchors and other attachments indicated or necessary to secure stone countertops in place.]**

7. Bond joints with stone adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

   a. Install metal splines in kerfs in stone edges at joints**[where indicated]**. Fill kerfs with stone adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
   b. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

8. Space joints with 1.5-mm (1/16-inch) gap for filling with **[grout] [sealant]**. Use temporary shims to ensure uniform spacing.

   a. **[Install metal splines in kerfs in stone edges at joints[where indicated]. Fill kerfs with [setting adhesive] [sealant] before inserting splines and remove excess immediately after adjoining units are drawn into position.]**
   b. **[Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.]**

9. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Use power saws with diamond blades to cut stone. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

10. **[Install backsplashes and end splashes by adhering to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Leave 1.5-mm (1/16-inch) gap between splashes and wall for filling with sealant. Use temporary shims to ensure uniform spacing.]**
11. **[Install backsplashes and end splashes by adhering to wall with water-cleanable epoxy adhesive. Leave 1.5-mm (1/16-inch) gap between countertop and splashes for filling with sealant. Use temporary shims to ensure uniform spacing.]**

M. Solid Surfacing Countertops:

1. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
2. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

   a. **[Install metal splines in kerfs in countertop edges at joints[where indicated]. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.]**

b. **[Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.]**

3. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
4. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
5. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

3.4 REPAIR

A. Repair damaged and defective interior architectural woodwork, where possible, to eliminate functional and visual defects**[and to result in interior architectural woodwork being in compliance with requirements of Architectural Woodwork Standards for the specified grade]**.

B. Where not possible to repair, replace defective woodwork.

C. Shop Finish: Touch up finishing work specified in this Section after installation of interior architectural woodwork.

1. Fill nail holes with matching filler where exposed.
2. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

D. Field Finish: See **[Division 09 Section "Interior Painting"] [and] [Division 09 Section "Staining and Transparent Finishing"]** for final finishing of installed interior architectural woodwork not indicated to be shop finished.

3.5 CLEANING

A. Clean interior architectural woodwork on exposed and semiexposed surfaces.

B. Stone Countertops:

1. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
2. Remove and replace stone countertops of the following description:

a. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Project Director/COR.
b. Defective countertops.
c. Defective joints, including misaligned joints.

d. Interior stone countertops and joints not matching approved Samples and mockups.
e. Interior stone countertops not complying with other requirements indicated.

3. Replace in a manner that results in stone countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.
4. Clean stone countertops no fewer than six days after completion of **[sealant installation] [installation]**, using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that may damage stone.
5. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

3.6 PROTECTION

A. Protect installed products from damage from weather and other causes during construction.

B. Remove and replace interior architectural woodwork materials that are wet, moisture damaged, and mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 064023

SECTION 074115 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes standing-seam metal roof panels.

B. Related Sections include the following:

1. Division 06 Section on Rough Carpentry for wood nailers, curbs, and blocking.
2. Section 076205 “Sheet Metal Flashing and Trim.”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Project Director/COR, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of **[deck] [purlins and rafters]** during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
8. Review temporary protection requirements for metal panel systems during and after installation.
9. Review procedures for repair of metal panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Sustainable Design Submittals:

1. Product Test Reports: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirements.
2. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1:10 (1-1/2 inches per 12 inches).

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 300 mm (12 inches) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

C. Sample installations: Build sample installations to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build sample installation of typical roof area and eave, including fascia, and soffit **[as shown on Drawings]**; approximately 1200 mm (48 inches) square by full thickness, including attachments, underlayment, and accessories.
2. Approval of sample installations does not constitute approval of deviations from the Contract Documents contained in sample installations unless Project Director/COR specifically approves such deviations in writing.
3. Approved sample installations may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

C. Installation Warranty: provide 2-year guarantee covering the proper material or product application preventing failure due to hot-water corrosion, damage due to inappropriate slip sheet, absorptive separation material, or other installer induced failure.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. [Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.]

B. Solar Reflectance Index (SRI): Three-year-aged SRI not less than **[64] [32]** or initial SRI not less than **[82] [39]** when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

C. [Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for [low] [steep]-slope roof products.]

D. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E72:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: **[As indicated on Drawings] <Insert loads>.**
3. Deflection Limits: For wind loads, no greater than [**1/180**] [**1/240**] <**Insert deflection**> of the span.
4. **<Insert serviceability requirements>**.

E. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E1680[**or ASTM E283**] at the following test-pressure difference:

1. Test-Pressure Difference: **[1.57 lbf/sq. ft. (75 Pa)] [6.24 lbf/sq. ft. (300 Pa)]**.

F. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646[**or ASTM E331**] at the following test-pressure difference:

1. Test-Pressure Difference: **[2.86 lbf/sq. ft. (137 Pa)] [6.24 lbf/sq. ft. (300 Pa)]**.

G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: **[UL 30] [UL 60] [UL 90]**.

2. Hail Resistance: **[MH] [SH]**.

2.2 STANDING-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels <**Insert drawing designation**>: Formed with vertical ribs at panel edges and **[intermediate stiffening ribs symmetrically spaced] [a flat pan]** between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

C. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, Z275 (G90) coating designation, or aluminum-zinc alloy-coated steel

sheet complying with ASTM A 792/A 792M, Class AZM150 (Class AZ50) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Nominal Thickness: [**0.71 mm (0.028 inch)**] [**0.86 mm (0.034 inch)**] [**1.02 mm (0.040 inch)**] [**1.32 mm (0.052 inch)**].
2. Exterior Finish: Two-coat fluoropolymer.
3. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR from manufacturer's full range]**.

D. Aluminum Sheet: Coil-coated sheet, ASTM B 209M (ASTM B 209), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Thickness: [**0.81 mm (0.032 inch)**] [**1.02 mm (0.040 inch)**].
2. Surface: **[Smooth, flat] [Embossed]** finish.
3. Exterior Finish: Two-coat fluoropolymer.
4. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR from manufacturer's full range]**.

E. Clips: **[One-piece fixed] [Two-piece floating]** to accommodate thermal movement.

1. Material: **[0.71-mm- (0.028-inch-)] [1.63-mm- (0.064-inch-)]** nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
2. Material: [**0.64-mm- (0.025-inch-)**] [**1.59-mm- (0.062-inch-)**] thick, stainless-steel sheet.

F. Panel Coverage: [**254 mm (10 inches)**] [**305 mm (12 inches)**] [**356 mm (14 inches)**] [**406 mm (16 inches)**] [**457 mm (18 inches)**] [**610 mm (24 inches)**] <Insert dimension>.

G. Panel Height: [**25 mm (1.0 inch)**] [**38 mm (1.5 inches)**] [**44 mm (1.75 inches)**] <Insert dimension>.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 0.75 mm (30 mils) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 116 deg C (240 deg F); ASTM D 1970.
2. Low-Temperature Flexibility: Passes after testing at minus 29 deg C (20 deg F); ASTM D 1970.

B. Felt Underlayment: ASTM D 226/D 22M, Type II (No. 30), asphalt-saturated organic felts.

C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90Z275 hot-dip galvanized coating designation or ASTM A 792/A 792M, Class AZM150 (Class AZ50) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 25-mm- (1-inch-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 2400-mm- (96-inch-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 900 mm (36 inches) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match **[metal roof panels] [roof fascia and rake trim]**.

E. Downspouts: Formed from same material as roof panels. Fabricate in 3-m- (10-foot-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

F. Roof Curbs: Fabricated from same material as roof panels, 1.2-mm (0.048-inch) nominal thickness; with bottom of skirt profiled to match roof panel profiles and with welded top box and integral full-length cricket. Fabricate curb subframing of 1.5-mm- (0.060-inch-) nominal thickness, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads of size and height indicated. Finish roof curbs to match metal roof panels.

1. Insulate roof curb with 25-mm- (1-inch-) thick, rigid insulation.

G. Panel Fasteners: Self-tapping screws designed to withstand design loads.

H. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 13 mm (1/2 inch) wide and 3 mm (1/8 inch) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

   1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.013 mm (0.5 mil).

D. Aluminum Panels and Accessories:

   1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

   1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

3. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated **[below] [on Drawings]**, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 150 mm (6 inches) staggered 600 mm (24 inches) between courses. Overlap side edges not less than 90 mm (3-1/2 inches).**[Extend underlayment into gutter trough.]** Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.
2. Apply over the roof area indicated below:

   a. Roof perimeter for a distance up from eaves of **[600 mm (24 inches)] [900 mm (36 inches)] <Insert dimension>** beyond interior wall line.
   b. Valleys, from lowest point to highest point, for a distance on each side of **[450 mm (18 inches)] <Insert dimension>**. Overlap ends of sheets not less than 152 mm (6 inches).
   c. Rake edges for a distance of **[450 mm (18 inches)] <Insert dimension>**.
   d. Hips and ridges for a distance on each side of **[300 mm (12 inches)] <Insert dimension>.**
   e. Roof-to-wall intersections for a distance from wall of **[450 mm (18 inches)] <Insert dimension>**.
   f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of **[450 mm (18 inches)] <Insert dimension>.**

B. Felt Underlayment: Apply at locations indicated **[below] [on Drawings]**, in shingle fashion to shed water, and with lapped joints of not less than 50 mm (2 inches).

1. Apply over the entire roof surface.
2. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 75 mm (3 inches), in shingle fashion to shed water.

C. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

D. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076205 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.

3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Watertight Installation:

a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
c. At panel splices, nest panels with minimum 150-mm (6-inch) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 3 m (10 feet) with no joints allowed within 610 mm (24 inches) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 25 mm (1 inch) deep, filled with mastic sealant (concealed within joints).

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 900 mm (36 inches) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 25 mm (1 inch) away from walls; locate fasteners at top and bottom and at approximately 1500 mm (60 inches) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

J. Roof Curbs: Install flashing around bases where they meet metal roof panels.

K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 6 mm in 6 m (1/4 inch in 20 feet) on slope and location lines as indicated and within 3-mm (1/8-inch) offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074115

SECTION 074215 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Project Director/COR, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1:10 (1-1/2 inches per 12 inches).

D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below.

1. Metal Panels: 300 mm (12 inches) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Sample Installations: Build sample installations to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build sample installation of typical metal panel assembly as shown on Drawings, including **[corner,] [soffits,]** supports, attachments, and accessories.
2. Approval of sample installations does not constitute approval of deviations from the Contract Documents contained in sample installations unless Project Director/COR specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved sample installations may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: 10-years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10-years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace insulated metal wall panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 5-years from date of Substantial Completion.

D. Installation Warranty: 2-years standard material workmanship warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. [**Recycled Content**: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert value> percent.]

B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E72:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: **[As indicated on Drawings] <Insert loads>.**
3. Deflection Limits: For wind loads, no greater than [**1/180**] [**1/240**] <**Insert deflection**> of the span.
4. **<Insert serviceability requirements>**.

C. Air Infiltration: Air leakage of not more than 0.3 L/s per sq. m (0.06 cfm/sq. ft.) when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: **[75 Pa (1.57 lbf/sq. ft.)] [300 Pa (6.24 lbf/sq. ft.)]**.

D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: **[135 Pa (2.86 lbf/sq. ft.)] [300 Pa (6.24 lbf/sq. ft.)]**.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): **[67 deg C (120 deg F), ambient; 100 deg C (180 deg F), material surfaces] <Insert temperature range>**.

F. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E 119.
2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
3. Radiant Heat Exposure: No ignition when tested according to NFPA 268.
4. Potential Heat: Acceptable level when tested according to NFPA 259.
5. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E 84.

2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

a. Closed-Cell Content: 90 percent when tested according to ASTM D 6226.
b. Density: 32 to 42 kg/cu. m (2.0 to 2.6 lb/cu. ft.) when tested according to ASTM D 1622.
c. Compressive Strength: Minimum 140 kPa (20 psi) when tested according to ASTM D 1621.
d. Shear Strength: 179 kPa (26 psi) when tested according to ASTM C 273/C 273M.

B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels <**Insert drawing designation**>: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, Z275 (G90) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZM150 (Class AZ50)

coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Nominal Thickness: **[0.56 mm (0.022 inch)] [0.71 mm (0.028 inch)] [0.86 mm (0.034 inch)]**.
b. Exterior Finish: Three-coat fluoropolymer.

1) Color: As selected by Project Director/COR from manufacturer's full range.

c. Interior Finish: Siliconized polyester.

1) Color: As selected by Project Director/COR from manufacturer's full range.

2. Backer Board: On back side of exterior facing.
3. Panel Coverage: [**900 mm (36 inches)**] [**1000 mm (40 inches)**] nominal.
4. Panel Thickness: [**25 mm (1.0 inch)**] [**38 mm (1.5 inches)**] [**50 mm (2.0 inches)**] [**62 mm (2.5 inches)**] [**75 mm (3.0 inches)**] [**100 mm (4.0 inches)**] [**125 mm (5.0 inches)**].
5. Thermal-Resistance Value (R-Value): R-19 according to ASTM C 1363.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90Z275 hot-dip galvanized coating designation or ASTM A 792/A 792M, Class AZM150 (Class AZ50) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 25-mm- (1-inch-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Backer Board: Hardboard complying with ANSI A135.4, Class 1 tempered, **[3 mm (1/8 inch)] [6 mm (1/4 inch)]** thick unless otherwise indicated.

D. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

E. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 13 mm (1/2 inch) wide and 3 mm (1/8 inch) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Steel: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Exterior Three-Coat Fluoropolymer Finish: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Interior Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.005 mm (0.2 mil) for primer and 0.02 mm (0.8 mil) for topcoat.
3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.013 mm (0.5 mil).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

3. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Division 07 Section on "Joint Sealants."

3.4 INSULATED METAL WALL PANEL INSTALLATION

A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.

B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.

1. Install clips to supports with self-tapping fasteners.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 3 m (10 feet) with no joints allowed within 600 mm (24 inches) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 25 mm (1 inch) deep, filled with mastic sealant (concealed within joints).

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of assembly as directed by Project Director/COR for water penetration according to AAMA 501.2.

C. Metal wall panels will be considered defective if they do not pass test and inspections.

D. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074215

SECTION 075558 - FLUID-APPLIED PROTECTED MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fluid-applied roof assembly using hot rubberized-asphalt membranes in Protected Membrane Roof (PMR) assembly.

B. Related Sections include the following:

1. Division 06 Section on Rough Carpentry for wood nailers, curbs, and blocking.
2. Section 076205 “Sheet Metal Flashing and Trim.”
3. Division 22 Section on Storm Drainage Piping Specialties for roof drains.

1.2 PERFORMANCE REQUIREMENTS

A. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A roof covering.

B. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements of FM Global 4450 or FM Global 4470 as part of a roofing system, and shall be listed in FM Global’s “RoofNav” for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: **[Class 1A-60] [Class 1A-75] [Class 1A-90] [Class 1A 105] [Class 1A-120]**.
2. Hail Resistance Rating: **[MH] [SH]**.

1.3 SUBMITTALS

A. Product Data: For each type of product specified.

1. Identify manufacturer’s recommended pouring temperature; range is typically 182 deg C to 205 deg C (360 deg F – 400 deg F).

B. Shop Drawings:

1. Provide shop drawings and details at expansion joints, penetrations, curbs, control joints, drains, rise walls, roof edges, and terminations.
2. Show installation of membrane, protection course, drainage course, filter fabric, insulation, and overburden.

3. Shop drawing shall be signed by authorized representative of membrane manufacturer stating that submittal details conform to manufacturer's warranty requirements for this specific Project.

C. Samples:

1. Reinforcement fabric.
2. Smooth and granule-surfaced modified bitumen membrane flashing sheets.
3. Drainage course.
4. Insulation.
5. Filter fabric.
6. Paver.

D. Certificates:

1. Submit manufacturer's certification stating materials ordered and supplied are compatible with each other and suited for purpose intended.
2. Submit letter indicating that manufacturer has reviewed project documents and will issue the specified warranty upon successful completion of the installation.
3. Submit manufacturer's current approval of installer and date of initial certification.

E. Certified Test Results: Submit certification showing that each batch of material is tested to ensure conformance with the manufacturer's published physical properties.

F. Qualification Data: List of projects of similar nature by both manufacturer and applicator which have been installed during last five years.

G. Warranties: Submit two copies conforming to warranty requirements of this Section.

1.4 QUALITY ASSURANCE

A. Installer qualifications:

1. Approved by manufacturer of accepted roofing system.
2. A single applicator with a minimum of five years previous successful experience in installations of similar systems.

B. Manufacturer qualifications: Minimum ten years previous successful experience in installations of similar systems.

C. Conformance with Regulatory Requirements:

1. Products manufactured in the United States shall conform to U.S. Federal regulations, safety standards, and codes.

2. Products manufactured in countries outside the United States shall be approved by Governing sanctioning entity for country; either country in which project is located or product is manufactured may be used.

D. Laboratory Testing and Samples:

1. Obtain field samples of the completed roof membrane, laps, and/or assembly.
2. Take samples at locations designated by Project Director/COR, and test for compliance with the requirements on the Contract Documents and with manufacturer's published performance criteria.
3. Perform test in accordance with ASTM methods applicable to this system.
4. Contractor is responsible for all costs of extraction and patching of roofing samples, and for testing.
5. Correct deficiencies identified by tests in accordance with the manufacturer's recommended procedures.
6. If for any reason, areas that are tested fail to meet requirements of this Section and manufacturer, costs associated with re-sampling, re-testing, correcting, and patching is the responsibility of the Contractor.

E. Deviation from Construction Drawings or approved Shop Drawings is not permitted without prior written approval from Project Director/COR and roof membrane manufacturer.

F. Obtain written approval from the manufacturer for any materials not manufactured or provided by manufacturer stating that materials are acceptable and are compatible with other materials and systems required.

G. Pre-installation Conference: Conduct conference at Project site. Comply with requirements in Division 01 Section "Construction Execution and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with Project Director/COR, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions. Review roofing contractor’s application procedures for a torch applied roof. Verify that all of roofing subcontractor’s personnel that will be using a torch on the roof has a current certification.
3. Review and finalize construction schedule in relation to activities of this Section, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.

6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations, and requirements for certificates.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

H. Upon completion of installation, a technical representative of the manufacturer to certify that roofing system has been installed according to manufacturer’s most current published specifications and details shall conduct an inspection.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers or packages with labels intact and legible.

B. Store materials in accordance with manufacturer's recommendations. Store rolled goods up on roll ends on clean raised platforms. Store other materials in dry area, protected from water and direct sunlight, and maintain at a temperature of 16 to 27 deg C (60 to 80 deg F).

C. Provide continuous protection of materials against deterioration.

D. Materials Stored on Roof Levels for Immediate Use:

1. Distribute to prevent concentrated loads that would impose excessive strain on deck or structural members.
2. Positively secure to prevent displacement by wind.
3. Tarp for protection from exposure.

1.6 PROJECT CONDITIONS

A. Environmental Requirements:

1. Apply roofing in dry weather.
2. Do not expose membrane and accessories to a constant temperature in excess of 82 deg C (180 deg F).

1.7 SEQUENCING AND SCHEDULING

A. Do not install more roofing in one day than can be night sealed with roofing and flashing in the same day.

1.8 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.

1. Install in such a manner that the roof system manufacturer will furnish a written warranty agreeing to replace/repair defective materials, including leakage of water, abnormal aging or deterioration of materials, and other failures of the materials to perform as required within warranty period.
2. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, roofing accessories, roof pavers, and other components of membrane roofing system.
3. Warranty Period: Ten years from date of Substantial Completion.

B. Contractor's Workmanship Warranty: In addition, furnish a written warranty agreeing to repair/replace defective installation and workmanship labor causing leakage of water, deterioration of materials, and other failures of the installed system, sealants, painting, coatings, and related work on this project, to perform as required within the warranty period.

1. Warranty Period: **[10] [5]** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRODUCT LISTINGS

A. Subject to compliance with requirements, provide comparable products to those listed in this Section.

2.2 SHEET MATERIALS

A. Roofing Membranes:

1. American Hydrotech, Inc.; Monolithic Membrane 6125.
2. American Permaquik Inc.; Permaquik 6100.
3. Barrett Company; Ram-Tough 250.
4. Henry Company; 790-11.

B. Primary Membrane:

1. Primary waterproofing membrane shall be hot-applied rubberized asphalt composed of specially selected blend of refined asphalts, synthetic rubber and mineral stabilizers, and having the physical properties identified below. References to Canadian General Standards Board (CSGB) standards are only to identify the key source document for the requirements;

the performance requirements listed in this Section govern over any values identified in the CSGB standards.

a. Solids Content: 100 percent.
b. Low Temperature Flexibility and Adhesion: No cracking, delamination, or loss of adhesion at -11 deg C (13 deg F) in accordance with CGSB 37-GP-50-M89, "Hot Applied Rubberized Asphalt for Roofing and Waterproofing."
c. Flow 3 mm (1/8-inch) film on 75% angle for 5 hours at 60 deg C (140 deg F): No flow in accordance with ASTM D5329.
d. Cone Penetration: More than 10 at 0 deg C (32 deg F), less than 110 at 25 deg C (77 deg F), less than 200 at 50 deg C (122 deg F) in accordance with ASTM D5329.
e. Water Absorption: Gain of 0.09g in accordance with CGSB 37-GP-50-B89.
f. Flash Point (Open Cup): 285 deg C (545 deg F) in accordance with ASTM D92.
g. Water Vapor Permeance (3mm Film): 0.01 perms in accordance with ASTM E96 Procedures A and 0.02 perms in accordance with ASTM E96 Procedure E.
h. Ratio of Toughness to Peak Load: 0.04 minimum in accordance with CGSB 37-GP-50-M89.
i. Toughness: 9.2J in accordance with CGSB 37-GP-50-M89.
j. Crack Bridging Capability: No cracking, splitting, or loss of adhesion in accordance with CGSB 37-GP-50-M89.
k. Heat Stability (5 hours at 200 deg C (390 deg F): Meets flow, penetration and low temperature flexibility in accordance with CGSB 37-GP-50-M89.1.
l. Recycled Content: 11 percent for standard membrane.

C. Membrane Fabric Reinforcement, an inorganic spun bonded polyester fabric reinforcement sheet, 39 gm/sq m (1.18 oz/sq yd) of sufficient porosity to allow good interplay bonding between layers of membrane:

1. "CCW-500 Reinforcing Fabric" by Carlisle Coatings and Waterproofing (CCW).
2. As supplied or recommended by membrane manufacturer for membrane system.

D. Surface Conditioner for concrete surfaces:

1. "Surface Conditioner" by American Hydrotech, Inc.
2. As supplied or recommended by the membrane manufacturer for membrane system.

E. Flashing: Provide one of the following two base flashing systems. Provide Neoprene flashing as underlayment course for either system.

1. SBS-Modified Bituminous Flashing Sheet: ASTM D 6164, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet.

a. Base Ply: Grade S, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified.

b. Top Ply: Grade G, granular surfaced; suitable for application method specified. Granular color, white.

2. APP-Modified Bituminous Flashing Sheet: ASTM D 6222, Type I or Type II, polyester-reinforced, APP-modified asphalt sheet; suitable for application method specified.

a. Base Ply: Grade S, smooth surfaced.
b. Top Ply: Grade G, granular surfaced. Granule color, white.

2.3 RELATED MATERIALS:

A. Primer, synthetic rubber-based or bituminous-based type primer:

1. “920-18 Primer” by Henry.
2. “CCW-550 Primer” by CCW.
3. As supplied by membrane manufacturer for membrane system.

B. Asphalt Primer for Modified Bitumen Flashings: ASTM D 41.

C. Separation/Protection Course: Formulated rubberized asphalt separation/protection sheet with synthetic fiber reinforcement:

1. “Hydroflex 10” by American Hydrotech, Inc.
2. “modifiedPLUS” by Henry.
3. “Protection Cap 250FR” by CCW.
4. As supplied or recommended by membrane manufacturer for membrane system.

D. Prefabricated Drainage Course, a composite drainage system consisting of a three-dimensional, crush-proof, drainage core and a non-woven needle punched filter fabric on one side of the core:

1. ‘Hydrodrain 300, 400, 700, or 1000” by American Hydrotech, Inc.
2. “DB200”, “DB350”, “DB500”, or “DB656” by Henry.
3. “MiraDrain” by CCW.
4. As supplied or recommended by membrane manufacturer for membrane system.

E. Filter Fabric Sheet, non-woven, water permeable polymeric fabric:

1. “Filter Fabric Sheet” by American Hydrotech, Inc.
2. “HP Protection Mat” by CCW.
3. As supplied or recommended by membrane manufacturer for membrane system.

F. Termination Bar: Stainless steel, type 302/304, 3 mm (11 gauge) minimum, 25 mm (1-inch) wide. Pre-drill fastener holes at 150 mm (6-inches) on-center.

G. Rubberized Asphalt Mastic:

1. "Monolithic Membrane 7800" by American Hydrotech.
2. "CCW-704 Mastic" by CCW.
3. As supplied or recommended by membrane manufacturer for membrane system.

H. Edge Sealant: Rubberized asphaltic plastic roof cement that is gun-grade version for sealing top edges of base flashings and terminations of cap sheet.

1. "Elastomastic 209" by Henry Co.
2. "Ruberoid" by GAF.
3. "BlackJack 1010" by Gibson Homas.
4. "SBS Mastic" by Soprema.

I. Elastomeric Plastic Roof Cement: Rubberized plastic roof cement/adhesive to be used for temporary seals of flashings and three coursing of seams and cuts in modified bitumen sheets.

1. "Ruberoid" by GAF.
2. "MBR Utility Cement" by Johns Manville.
3. "MB Gold Elastomeric Flashing Cement" by Monsey.
4. "PA-1021" by Siplast,
5. "SBS Elastic Cement" by Soprema.

J. Precast Concrete Paver Ballast:

1. Locally fabricated and sources materials subject to U.S. standards.
2. Precast Pavers: Nominal size 300 mm by 300 mm by 50 mm thick (12-inch by 12-inch by 2-inch).
3. Compressive strength of 20,000 kN/m2 (3000 psi).
4. In locations with freezing climates, provide plain-steel welded wire reinforcement: 29 mm dia (9 gauge). Provide two bars in each direction; space approximately 75 mm (3-inches) from each edge, leaving about 150 mm (6-inches) between parallel bars. Reinforcement shall not be visible on any surface.
5. Non-skid top finish free of voids, smooth bottom finish with beveled or rounded bottom edges and corners free of fins and projections.
6. Natural concrete color (grey).

2.4 INSULATION:

A. Loose Laid Insulation: Extruded polystyrene foam board, 24 to 26 kg/m^3 density, 276 kN/m^2 (40 psi) compressive strength, ASTM C-578-85, 600 mm by 2,400 mm (24-inch by 96-inch) sized boards.

1. "Styrofoam Roofmate" by Dow Chemical Co.
2. "CertiFoam 25" by DiversiFoam Products.
3. "Foamular" by Owens Corning.

B. Heat Resistant Insulation: Molded hydrous calcium silicate-based or perlite-based heat resistant rigid pipe insulation. Insulation shall be pre-manufactured, and sized for installation around circular/tubular element.

1. "Calsilite Pipe Insulation" by Calsilite Manufacturing Corporation
2. "Sproule Pipe Insulation" by Industrial Insulation Group
3. "Thermo-12 Gold" by Johns Manville

C. Compressible Fill Insulation: Foil or paper faced compressible fiberglass batten roll insulation. Insulation shall be proper size and thickness to insert at openings at penetrations, perimeters, and curbs.

1. Foil- or paper-faced compressible fiberglass batten roll insulation as manufactured by Owens Corning.

PART 3 - EXECUTION

3.1 EXAMINATION OF SURFACES

A. Contractor shall examine the substrate, roof deck, and related surfaces and verify that there are no conditions such as inadequate anchorage, foreign materials, moisture, ridges, or other conditions, which would prevent the satisfactory installation of the roofing system.

B. Verify that concrete deck has been prepared and is in condition to receive waterproofing materials.

1. Concrete has wood float or wood trowel finish.
2. Concrete was moist cured and free of curing compounds.
3. Concrete was cured for minimum of 28 days prior to application of waterproofing membrane.
4. Perform moisture test by taping down 300 mm x 300 mm (12-inch x 12-inch) x 0.15 mm (6-mil) clear polyethylene sheet to concrete and observe for condensation on underside of polyethylene in 4 hour cycles. Apply roof asphalt primer once no condensation is observed.

C. Correct or complete any condition requiring correction or completion prior to installation of roofing system. Notify Project Director/COR in writing of unacceptable conditions.

D. Verify the location of electrical lines, piping, conduit, and similar obstructions. Perform work in such a manner as to avoid contact with the above-mentioned items.

E. Start of Execution for work of this Section constitutes acceptance of substrate and site conditions.

3.2 PREPARATION

A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for roofing application.

B. Mask off adjoining surfaces not receiving roofing to prevent spillage from affecting other construction.

C. Mask and protect substrates at locations to receive new sealants and locations above the top of the finished traffic surface.

D. Apply test patch of surface conditioner and waterproofing membrane and verify adhesion to substrate.

E. Apply surface conditioner as recommended by manufacturer for horizontal and vertical surfaces.

F. Protect roof drains and other deck penetrations to prevent spillage and migration of roofing fluids.

G. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

H. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

I. Remove contaminants from metal surfaces which may adversely affect adhesion or performance of coating system and apply asphalt primer.

3.3 CONTROL JOINTS, CONSTRUCTION JOINTS AND CRACKS

A. Prepare and treat substrates to receive roofing membrane, including joints and cracks, roof drains, and penetrations, according to roofing system manufacturer's written instructions.

B. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt according to ASTM D 4258.

1. Apply 3 .2 mm (125-mil) coat of hot rubberized asphalt approximately 450 mm (18-inches) wide over crack.
2. Embed strip of reinforcing fabric into a layer of hot fluid-applied, rubberized asphalt and roll fabric down into hot membrane.
3. Extend reinforcing fabric a minimum of 150 mm (6-inches) on each side of nonmoving joints and cracks, and beyond roof drains and penetrations.
4. Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.

C. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 150 mm (6-inches) on each side of joints and adhere to

substrates in a layer of hot fluid-applied, rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

3.4 BASE FLASHING INSTALLATION – BASE PLY

A. Installation of exposed Neoprene flashing is not permitted.

B. Install base ply of modified bitumen base flashing extending horizontally 100 mm (4-inches) beyond edge of cant or flange and vertically 100 mm (4-inches), minimum above the top of the cant.

C. Length of base flashings shall be maximum 2 m (6-feet). Lap ends of base flashings 100mm (4-inches), minimum. Seal top edge of base flashing on a daily basis with a continuous troweling of elastomeric roof cement.

D. Check lap seams and seal unbonded or discontinuous seams using a heated steel trowel.

3.5 DRAINS

A. Apply 3.2 mm (125 mil) coat of hot rubberized asphalt extending approximately 450 mm (18-inches) from the drain clamping flange or ring.

B. Apply elastomeric sheet extending approximately 300 mm (12-inches) from the drain clamping flange or ring and roll down into hot membrane.

C. Apply second 3.2 mm (125-mil) coat of hot rubberized asphalt over the elastomeric sheet if required by the waterproofing membrane manufacturer.

D. Temporarily block drains during membrane and flashing application.

3.6 ROOFING MEMBRANE APPLICATION

A. Install in accordance with manufacturer’s current published application procedures, and recommendations of “The NRCA Roofing and Waterproofing Manual” from National Roofing Contractor’s Association (NRCA).

B. Manufacturer's technical representative shall be present as work proceeds on detail areas such as crack repair and work at expansion joints. Install materials in accordance with manufacturer's printed instructions.

C. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow to dry.

D. Heat rubberized asphalt until free flowing, generally 190 to 205 deg C (375 to 400 deg F), but not above 205 deg C (400 deg F). Heat rubberized asphalt in double-jacketed, oil-bath melter with mechanical agitator. Recommended pouring temperature range is 182 to 205 deg C (360 to 400 deg F).

E. Apply uniform coating of hot rubberized asphalt to substrate and adjoining surfaces indicated to receive membrane using squeegee complying with manufacturer's recommendations.

F. Apply hot rubberized asphalt membrane at a rate to provide a continuous, monolithic coating of 90 mils minimum. Fully embed a layer of the spunbonded polyester fabric reinforcing sheet overlapping adjacent layers 200 mm (8-inches). Apply a second layer of continuous monolithic coat of hot rubberized asphalt membrane at a minimum thickness of 3.2 mm (125-mils) resulting in a total membrane thickness of 5.5 mm (215-mils) minimum.

G. Overlap fabric reinforcing sheet 50mm (2-inches) minimum with hot rubberized asphalt membrane applied between the overlapped fabric sheets.

H. Cover waterproofing with protection course with overlapped joints before membrane is subject to construction traffic. Protection course also prevents insulation from sticking to membrane.

I. Daily Seal:

1. Install temporary night seal at completion of each day's work and remove upon resumption of work.
2. Ensure that water does not flow beneath any completed sections of the membrane system. This will include completion of all flashings, terminations, and daily seals. When possible, install starting at the highest point of the project area, working to the lowest point.
3. Seal membrane edge with continuous troweling of plastic roof cement. Caution must be exercised to ensure that membrane is not temporarily sealed near drainage medium in such a way to promote water migration below the membrane or impede drainage.
4. Install daily night seal in such a manner to seal new roof system to roof deck to prevent moisture migration from either new roof or exposed concrete deck.
5. Install daily night seals by extending the new roof membrane beyond the insulation and sealing to the existing roof surface using plastic cement.
6. When work is resumed, remove and dispose of membrane where cement or other sealants were previously applied before resuming installation.

J. Heat Exhaust Vents:

1. Install heat resistant insulation around vent pipe through roof.
2. Install new sheet metal base around insulation and strip flange into new roof.

K. Insulation Filler: Install compressible fiberglass insulation at openings in deck at penetrations, perimeters, and/or curbs.

3.7 BASE FLASHING APPLICATION – TOP PLY

A. Installation of exposed neoprene flashing is not permitted.

B. Apply top ply of modified bitumen flashings only after roofing membrane application has been completed.

C. "Torch de-granulate" or prime granulated surfaces of flashings to receive flashing. Pre-heat the subject area of the underlying granule-surfaced sheet so that granules can be "depressed" or sunk into the compound and the bitumen compound exudes up through the granules to result in a bituminous material-to-bituminous material contact.

D. Prime granulated surfaces with a uniform coating of asphalt primer. Permit primer to dry prior to application of modified bitumen membrane flashing.

E. Cut modified bitumen flashing membrane to extend a minimum of 100 mm (4-inches) above the top of the membrane top ply covering the cant. The overall minimum height of the top of the flashing membrane above the top of the roof surface is 200 mm (8-inches) above the concrete paver ballast.

F. Extend the flashing membrane horizontally 100 mm (4-inches) onto the field of the roof surface beyond the bottom edge of the cant strip.

G. Cut flashing from roll using selvage edge as lap seam for adjacent sheets resulting in sheet lengths of nominal 1 m (3 feet).

H. Lap ends a minimum of 100 mm (4-inches) and stagger laps from laps of underlying plies.

I. Fully adhere and conform top ply of flashing to substrate. Extend bleed-out of applied base flashing a minimum of 13 mm (1/2-inch) beyond the side or end lap.

J. "Broom-in" the flashing ply immediately upon installation using a damp sponge mop.

K. Coat bleed-out on granulated sheets with granules to match finish surfacing.

L. Install three-coursing at vertical seams and termination bars:

1. Utilize masking or duct tape to create vertical and horizontal straight edge of three-coursing.
2. Apply elastomeric plastic roof cement embedded with reinforcing fabric at vertical lap seams and horizontal termination bars.
3. Apply final coat of elastomeric roof cement. After application of three-coursing, remove tape.
4. Embed granules into plastic cement, in any exposed areas of three-coursing immediately after application, to achieve uniform base flashing color.

M. Walls:

1. Mechanically attach top edge of modified bitumen membrane flashing with appropriate fasteners and termination bar. Fastener spacing shall be 150 mm (6-inches) on-center. Apply three-coursing over termination bars.

N. Curbs:

1. For curbs with non-removable hoods/covers/units, extend flashing to full height of curb and apply three-coursing. For curbs with removable hoods/covers/units, wrap flashing sheet over top of curb and secure to top or inside of curb with angle termination bar and appropriate fasteners spaced 150 mm (6-inches) on-center.
2. Apply a boot or oval section of modified bitumen sheet over outside corners of curb flashings to conceal cuts in flashing material at corner laps.
3. Install flashing sheets on adjoining perpendicular sides (outside corners) of curbs or walls so that outside corners of flashing sheet align and are rounded.

O. Metal Flange Flashing (Pitch Pans, Metal Edge, Pipe Boxes, Vent Stacks, etc.):

1. Prime top and bottom of metal flanges and components completely and allow to dry prior to installation.
2. Before membrane ply has been applied, install metal flange flashings in a bed of roof cement. Strip-in flange/metal with strips of base flashing (base ply) extending a minimum of 100 mm (4-inches) beyond edge of flange/metal.

3.8 SEPARATION/PROTECTION LAYER INSTALLATION

A. Install Separation/Protection Layer as Follows:

1. Embed the separator sheet into the membrane while it is still hot to ensure good bond.
2. Overlap adjoining sheet edges (dry) a minimum of 50 mm to 75 mm (2-inches to 3-inches) to ensure complete coverage.
3. The separator sheet must be covered by the drainage course and finish materials as soon as possible, within thirty days of membrane installation.

3.9 PROTECTED MEMBRANE ASSEMBLY

A. Flood Test: Prior to installation of protected membrane assembly, perform flood test in accordance to Article on FIELD QUALITY CONTROL.

B. Prefabricated Drainage Course:

1. Install drainage course in accordance with the manufacturer's recommendations.

2. Layout and position drainage course and allow to lay flat. Cut and fit drainage course to perimeter and penetrations. If drainage layer to be installed has polymeric sheet on bottom side, installation of the separator sheet on top of membrane is not required.
3. Overlap adjacent panels at ends and sides so laps of both the core and fabric are in the direction of flow of water.
4. Connect adjacent panels along longitudinal side utilizing the flangeless and flanged edges of adjoining panels. Connect ends of adjoining panels by interlocking two rows of dimples of both panels.
5. Expose two rows of dimpled core by pulling the filter fabric back at panel end. Place the end of the next two panels over the two rows of dimples and interlock.
6. Overlap edges of filter fabric material of adjacent drainage panels a minimum of 225 mm (9-inches) along longitudinal edge and 75 mm (3-inches) along ends.
7. Wrap drain assemblies with strip of drainage course material and secure with adjustable tie.
8. Wrap exposed edges of drainage course material with filter fabric.
9. Place subsequent topping materials as soon as possible.

C. Insulation:

1. Install extruded polystyrene insulation boards in two thick layers over the drainage course. Stagger the end joints of adjacent rows and joints of the bottom layer from joints of the top layer.
2. Fit all boards tightly, allowing no more than 6 mm (1/4-inch) between boards. Insulation should be cut and placed as necessary, to be not more than 50 mm (2-inch) from cant strips, walls, curbs, and projections through the roof.

D. Filter Fabric and Paver:

1. Once the drainage course and insulation have been placed over the entire area, install a single ply of the specified filter fabric, lapping each sheet not less than 150 mm (6-inches) over the preceding sheet.
2. Extend the fabric 50 mm (2-inches) to 75 mm (3-inches) over the end of the insulation board at penetrations and the perimeters.
3. Wrap ends of insulation board at perimeter edge conditions, risewalls, and penetrations. Extend loose edge of fabric 300 mm (12-inches) below edge of insulation board.
4. Fabric should be extended up to the base of the scuppers and drains, but should not cover the scupper/drain or in any way restrict the flow of water.
5. Install concrete pavers over filter fabric over the entire roof area. Cut pavers with masonry saw and place as necessary, including at junctures where roof slope changes.

3.10 FIELD QUALITY CONTROL

A. On start-up, raise the oil bath temperature of the meter to 230 deg C (450 deg F) maximum.

B. Do not hold material at pouring temperature for longer than five hours. If pouring is to be delayed, reduce temperature to between 132 deg C and 160 deg C (270 deg F – 320 deg F) and hold until pouring is to be resumed. Do not heat the compound above 210 deg C (410 deg F).

C. Prolonged heating (longer than five hours) or heating above 210 deg C (410 deg F) may cause the compound to gel in the melter. A rapid increase in viscosity of the material accompanied by stringiness indicates that gelling has begun. The compound temperature must be reduced promptly or the material should be removed promptly from the kettle.

D. Visually inspect surfaces for voids or ruptures and make necessary repairs.

E. Thickness Tests:

1. Before material attains final set, verify applied thickness in presence of Project Director/COR or their representative.
2. Obtain and record thickness measurement every 9.3 sq m (100 sq ft) of surface area. Submit report of thickness measurements and approximate locations of the measurements to Project Director/COR.
3. Where readings indicate thickness less than specified, immediately apply additional membrane to produce required thickness.

F. Perform peel and adhesion testing required by the manufacturer.

G. Do not permit traffic on roof after roofing membrane has been installed, other than for roofing installation, until roofing pavers have been installed.

H. Flood Testing: See Article on PROTECTED MEMBRANE ASSEMBLY of this Section for timing of testing.

1. Plug drains on horizontal surfaces.
2. Use sandbags or other means to restrict runoff.
3. Flood deck with water to depth of 50 mm (2-inches) from top of membrane.
4. Allow to stand forty-eight hours.
5. Repair leaks and retest.

I. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

1. Notify Project Director/COR 48 hours in advance of date and time of inspection.

J. Roofing system will be considered defective if it does not pass tests and inspections.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTING AND CLEANING

A. Protection:

1. Provide special protection or avoid heavy traffic on completed work when ambient temperature is above 26 deg C (80 deg F).
2. Restore to original condition or replace work or materials damaged during handling of roofing materials.
3. Emergency Edge Sealing Equipment: Maintain on-site equipment necessary to apply emergency temporary edge seal in the event of sudden storms or inclement weather.
4. Temporary Fire Protection Accessories: Minimum of two fully charged 9 kg (20-pounds) dry chemical fire extinguishers in separate, easily accessible torch work locations at all times.

B. Remove debris, adhesives, and sealants from surfaces.

C. Remove debris and material waste from Project site.

D. Remove bituminous deposits and/or stains from exposed/visible finishes on building, equipment, and/or appurtenances.

END OF SECTION 075558

SECTION 076205 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following shop or field-formed sheet metal work for moisture protection at roofing:

1. Roof penetration sleeves and counterflashing.
2. General metal roof counterflashing.
3. Expansion joint covers.
4. Roof drain flashing for primary drains.
5. Scuppers.
6. Vent hoods.
7. Pipe boxes.
8. Curb cap flashing.
9. Miscellaneous roof sheet metal accessories.

B. Related Requirements:

1. Division 06 Section on rough carpentry for wood nailers, curbs, and blocking.
2. Section 075558 “Fluid-Applied Protection Membrane Roofing.
3. **[Division 07 Section on XXX roofing system.]**
4. Division 07 Section(s) on roof accessories for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
5. Refer to other Sections for incidental flashing for purposes other than roofing.

1.2 STANDARDS

A. National Roofing Contractors Association (NRCA):

1. NRCA Roofing and Waterproofing Manual.

B. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):

1. Architectural Sheet Metal Manual.

1.3 SUBMITTALS

A. Product Data: For each type of product for underlayment, adhesives, sealants, and pourable pitch pan grout, and pourable sealers.

B. Shop drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work.

1. Identify material, thickness, weight, and finish for each item and location including profiles, shapes, seams and dimensions.
2. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats and attachments to adjoining work.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Unload, store and install sheet metal flashing and fabrications in a manner to prevent bending, warping, twisting and surface damage.

B. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.5 WARRANTY

A. Contractor's Workmanship Warranty: Coordinate inclusion of sheet metal flashing written warranty as part of membrane warranty which shall warrant sheet metal work to be free of leaks and defects in workmanship.

1. Warranty Period: **[10] [5]** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRODUCT LISTINGS

A. Subject to compliance with requirements, provide comparable products to those listed in this Section.

2.2 SHEET METAL MATERIAL

A. Stainless-Steel Sheet: ASTM A167, Type 302/304, softer temper. Thickness as specified for each application.

1. Use for all roof applications except roof drain flashing.
2. Finish: No. 4 (fine reflective, polished directional satin).

B. Sheet Lead: FS QQ-L-201,Grade B for roof drain flashing.

C. [Copper: ASTM B370, cold-rolled except where soft tempered required for forming, 4.87 kg/sqm, 0.548 mm thick (16 ounce/square foot).]

D. [Aluminum: ASTM B 209M, Alloy 6061-T6. Minimum thickness 0.8 mm for sheet and 2.0 mm for extruded materials. Alloy and temper recommended by manufacturer for use and structural performance for roofing. Mill finished.]

E. [Prefinished Aluminum: Sheet or extruded with full strength Kynar 500® PVDF resin-based coating with a top side dry film thickness of 0.70 to 0.80 mil over 0.20 to 0.30 mil prime coats. Coat reverse side with primer and wash coat of 0.30 mil plus or minus 0.05 mil.

1. Color: As selected from manufacturer's standard selection.]

F. [Titanium-Zinc: Fine zinc with copper, titanium and aluminum. European standards EN 988, DIN 18339, thickness 0.70 mm, size 500, tensile strength 110 N/mm^2. Galvanized steel or prefinished galvanized steel sheet metal products are not acceptable.

1. Finish: Bright rolled.

a. Basis of Design: Rheinzink.]

2.3 FASTENERS

A. Fasteners shall be of same metal as flashing and sheet metal, or noncorrosive metal.

B. Exposed fasteners shall be self-sealing or gasketed for watertight installation.

C. Heads of fasteners (including but not limited to rivets, screws, and bolts) that are exposed or visible shall have same manufactured finishes as item being secured, and color shall match where applicable.

D. Mechanical Fasteners:

1. Washers: Steel washers with bonded rubber sealing gasket.
2. Screws: Self-tapping sheet metal type compatible with material fastened.
3. Rivets: Stainless steel for head and stem, closed end, type and size and recommended by sheet metal manufacturer.

2.4 RELATED MATERIALS

A. Metal Accessories: Sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size, and gauge required for performance.

B. Underlayment: Modified bitumen roof flashings continued underneath sheet edge metal with slip sheet: Rosin-sized paper, minimum 0.16 kg (0.4-lb.)/sq. m..

1. Alternate products may include self-adhering roof underlayment for high temperature-applications.

a. Basis of Design: “ Ice & Watershield HT” by W. R. Grace.

C. Solder:

1. Use with Ferrous Metal or Copper: 50 percent tin, 50 percent lead solder, alloy grade 58, ASTM B 32.
2. Use with Stainless Steel: 60-40 tin/lead solder, ASTM B 32.

D. Flux:

1. Phosphoric acid type, manufacturer's standard.
2. Use with Stainless Steel: Acid-chloride type flux, except use rosin flux over tinned surfaces.
3. Use with Steel or Copper: Rosin flux. 50-50 tin/lead solder, ASTM B 32.

E. Adhesives: Type recommended by flashing sheet manufacturer for waterproof and weather-resistant seaming and for adhesive application of flashing sheet.

F. Sealant:

1. Polyurethane Sealant: One component polyurethane sealant, color to match finish of metal.

   a. Basis of Design: "Dynatrol I" by Pecora Corp.

2. Silicone Sealant: Low modulus silicone sealant for sealing metal-to-metal surface (i.e., metal edge, cover plates), color to match finish of metal.

   a. Basis of Design: "895 Silicone Building Sealant" by Pecora Corp.

3. Elastomeric Butyl Tape: Self-adhering elastomeric butyl tape, 3-mm by 9-mm (1/8-inch by 3/8-inch.

   a. Basis of Design: "Extru-Seal" by Pecora Corp.

G. Grout for Pitch Pans:

1. Quick setting formula: U.S. Army Corps of Engineers CRD-C-621 “Specification for Nonshrink Grout.”

   a. Basis of Design: “SonoGrout 10K” by Sonneborn Building Products.

H. Pourable Sealer:

1. Pourable polyurethane sealer, approved for compatibility by roofing system manufacturer.

   a. "Fillguard M Pourable Sealer" by Firestone
   b. "1-Part Pourable Sealant" by ChemLink.

I. Termination Bar: 3 mm (1/8-inch) thick, 25 mm (1-inch) wide stainless steel bar with flat profile, factory punched oval holes sized 6-mm by 9-mm (1/4-inch by 3/8-inch), and spaced 150mm (6-inches) on-center:

1. Basis of Design: "TB 125" by The TruFast Corp. or “Heavy Flat Bar” by Olympic.

J. Stainless Steel Clamp: Stainless steel banding with worm-drive tightening, sized for application.

1. Basis of Design: "Make-A-Clamp Kit" by Dynamic Fastener.

2.5 FABRICATION - GENERAL

A. Fabricate work in accordance with SMACNA Architectural Sheet Metal Manual and other recognized industry practices, and accepted shop drawings.

B. Comply with material manufacturer’s instructions and recommendations for forming material.

C. Shop-fabricate work to greatest extent possible. Fabricate inside and outside corners for metal edges, counterflashing, and coping caps.

D. Fabricate for waterproof and weather resistant performance with expansion provisions for running work sufficient to permanently prevent leakage, damage, or deterioration of work. Form work to fit substrates.

E. Make angle bends and folds for interlocking metal with full regard for expansion and contraction to avoid buckling or fullness in metal after installation.

F. Form materials with straight lines, sharp angles, smooth curves, and true levels. Avoid tool marks, buckling, and oil canning.

G. Fold back edges on concealed side of exposed edge to form hem.

H. Lap joints 25 mm (1-inch) minimum. Rivet and solder joints on parts that are to be permanently and rigidly assembled.

I. Seams:

1. Fabricate non-moving seams in sheet metal with flat-lock seams.
2. [Metal Other than Aluminum: Tin edges to be seamed, form seams, and solder.]

J. Expansion Provisions: Where lapped or bayonet type expansion provisions in work cannot be used, or would not be sufficiently waterproof or weatherproof, form expansion joints of intermeshing hooked flanges, not less than 25 mm (1-inch) deep, filled with mastic sealant concealed within joints.

K. Forming to Accept Sealant Joints: Where movable, non-expansion type joints are indicated or are required for proper performance of work, form metal to facilitate proper installation of elastomeric sealants in conformance with SMACNA “Architectural Sheet Metal Manual.”

2.6 SHEET METAL FABRICATIONS

A. Counterflashings: Minimum 0.635 mm (24 gauge) stainless steel, formed in maximum 3 meters (10 foot) lengths. Utilize two piece configuration at walls.

B. Penetration Flashing Pans and Bonnets: 0.635 mm (24 gauge) stainless steel. Fabricate pan with 6 mm (1/4-inch) hem at top edge and with 100 mm (4-inch) flanges with rounded corners. Fabricate to provide installed minimum clear inside perimeter dimension of 50 mm (2-inches) on each side of penetrating element and 150 mm (6-inch) height.

C. Angle Termination Bar: 25-mm by 25-mm (1-inch by 1-inch) angle of 0.635-mm (24 gauge_ stainless steel.

D. Expansion Joints Cover and Clips: Minimum 0.635 mm (24 gauge) stainless steel.

E. Roof Drain Flashing: 750-mm by 750-mm (30-inch by 30-inch) of 16 mm (0.63 inches) thick lead sheet.

F. Scupper: Minimum 0.635 mm (24 gauge) stainless steel.

G. Vent Hoods: Minimum 0.635 mm (24 gauge) stainless steel with 100 mm (4-inch) flanges with rounded corners.

H. Pipe Box (Base, Hood, and Face Plate): 0.635 mm (24 gauge) stainless steel. Base shall be 200 mm (8-inches) in height, 100 mm (4-inch) wide flanges with rounded corners and sized to provide minimum 50 mm (2-inch) clearance between pipes and box.

I. Continuous Cleats: Continuous strips, same base material, and fascia profile, and next heavier gauge available as adjacent metal item.

J. [Metal Edge: 0.635 mm (24 gauge) prefinished galvanized steel with 150 mm (6-inch) wide cover plates.]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrates are smooth and clean to extent needed for sheet metal work.

B. Verify that reglets, nails, cants, and blocking to receive sheet metal are installed and free of concrete and soil.

C. Do not start sheet metal work until conditions are satisfactory.

3.2 INSTALLATION

A. Install fabricated sheet metal items in accordance with manufacturer's installation instructions and recommendations and with SMACNA Architectural Sheet Metal Manual.

B. Install sheet metal with lines, arises, and angles sharp and true, and plane surfaces free from objectionable wave, warp, or buckle. Exposed edges of sheet metal shall be folded back to form 6 mm (1/4-inch) hem on concealed side from view.

C. Locate field joints not less than 300 mm (12-inches), nor more than 1 meter (3 feet) from actual corner. Laps shall be 25 mm (1-inch), riveted and soldered at following locations: prefabricated corners; transitions; changes in direction, elevation, and plane; and at intersections. Prefabricated corners or transitions are required at changes in direction, elevation, or plane, and at intersections. Finished work shall be free from water retention and leakage under all weather conditions in relation to joint, lap, and corner forming work.

D. Anchor units of work securely in place to prevent damage or distortion from wind or buckling. Provide for thermal expansion of metal units; conceal fasteners where possible; and set units true to line and level as indicated. Install work with laps, joints, and seams permanently watertight and weatherproof.

E. Separations: Provide for separation of metal from non-compatible metal or corrosive substrates by coating concealed surfaces with zinc chromate, bituminous coating, or other permanent separation at locations of contact as recommended by manufacturer or fabricator. Do not use materials incompatible with roofing system.

F. Counterflashings:

1. Install counterflashings under equipment housing flanges and new receivers along rise or parapet walls.
2. Secure counterflashing at 150 mm (6-inches) on-center with self-tapping screws.
3. Lap adjacent sections of receivers and counterflashings minimum of 100 mm (4-inches). Apply continuous bead of silicone sealant in lap.
4. **[At existing construction, saw cut joint in substrate as required to facilitate installation of new receiver and counterflashing. Clean and prepare joint surfaces to receive sealant. Apply continuous bead of silicone sealant along top edge of reglet.]**
5. **[Trim existing counterflashing to receive new flashing. Secure new flashing to receiver utilizing self-tapping screws spaced at 150 mm (6 inches) on center.**
6. **Install wind clips to termination bar spaced at 600 mm (24 inches) on center.]**

G. Penetration Pans:

1. Fully solder joints and connections.
2. Prime top and bottom of flanges.
3. Install with flanges set in uniform troweling of plastic roof cement on membrane base ply, secure and strip-in flanges.
4. Fill penetration pan to within 25 mm (1-inch) of top of pan with non-shrink grout. Fill remainder of pan with pourable sealer.

5. Install umbrella counterflashing or hood.

H. Roof Penetration Hoods and Umbrella Counterflashing:

1. Install watertight hood or umbrella counterflashing at sleeves and penetration locations, such as pipes and conduit penetrating roof, and at equipment supports and over penetration pans.
2. Round or Pipe Penetrations:

   a. Set umbrella counterflashing in silicone sealant.
   b. Fully solder connections and seams and install in accordance with Construction Drawings.
   c. Tighten draw bands.
   d. Seal top of umbrella counterflashing with silicone sealant.

3. Square Penetration:

   a. Secure umbrella counterflashing to penetration with self-drilling screw.
   b. Set umbrella counterflashing in elastomeric butyl tape.
   c. Seal top of umbrella counterflashing with silicone sealant.

4. Angle or Structural Steel Penetration:

   a. Attach umbrella counterflashing to structural steel member by welding.
   b. Paint assembly after installation.

I. Expansion Joint Cover:

1. Install wood curbs.
2. Install underlayment, form envelope, and secure underlayment to curb. Fill envelope with compressible insulation.
3. Securely fasten expansion joint cover to curb with grommeted fasteners spaced at 150 mm (6 inches) on center.

J. Roof Drain Flashing:

1. After membrane installation, prime bottom of lead flashing sheet and set in uniform bed of plastic roof cement at specified locations.
2. Extend lead flashing into drain bowl or pipe a minimum of 50 mm (2-inches) and over top of piping/bowl connection. Apply continuous bead of polyurethane sealant.
3. If drain bowl and pipe connection is contaminated with bituminous material, strip-in area with three-coursing of plastic roof cement and fabric.
4. Prime top surface of lead flashing sheet to receive strip-in membrane.

K. Scupper:

1. After field membrane is installed, install metal scupper insert into wall opening. Set scupper in bed of plastic roof cement, and secure flanges of scupper to wall and deck.
2. Strip-in flanges of scupper with appropriate flashing plies.

3. Install silicone sealant around exterior opening of scupper between metal insert and wall.

L. Pipe Box:

1. Prime top and bottom of flanges.
2. Fully solder joints and connections.
3. Install with flanges set in plastic roof cement on base ply, secure, and strip-in.
4. Fill pans with grout to height of 3/4 of total pan height.
5. Fill remaining height of pitch pans with pourable sealer.
6. Install hood over pan, securing to each side with self-tapping screws.
7. Install face plate to cover box opening around pipe penetrations.

M. Scupper:

1. After field membrane is installed, install metal scupper insert into wall opening. Set scupper in bed of plastic roof cement, and secure flanges of scupper to wall and deck.
2. Strip-in flanges of scupper with appropriate flashing plies.
3. Install silicone sealant around exterior opening of scupper between metal insert and wall.

N. Continuous Cleat:

1. At exposed edges of gravel guards, fascias, cap flashings, and where required, attach continuous cleat at 150 mm (6-inches) on-center with appropriate fasteners positioned on the vertical face.
2. At a distance of 3 meters (10 feet) from each direction of all outside or inside corners, install fasteners 75 mm (3-inches) on-center.

O. [Metal Edge:

1. Apply uniform continuous bead of plastic roof cement on roof membrane.
2. Embed strips of underlayment into plastic roof cement under metal edge. Extend underlayment from edge of flange to minimum 25 mm (1 inch) below bottom edge of nailer.
3. Prime bottom side of metal edge. Set in bed of plastic roof cement over membrane, and lock to cleat. Install adjacent section of metal edge with approximately 6-mm (1/4 inch) space between sections.
4. Secure horizontal flange of metal edge to wood nailer with appropriate fasteners spaced at 75 mm (3 inches) on center, staggered.
5. Install covers at joints, locking into cleat. Embed flange into plastic roof cement, and install continuous beads of silicone sealant placed on each side of joint on fascia. Fasten joint cover with appropriate fastener centered in joint.
6. Prime top metal surface of flange to receive strip-in membrane.]

3.3 CLEANING

A. Remove flux and residual acid immediately by neutralizing with baking soda and washing with clean water. Leave work clean and free of stains, scrap, and debris.

B. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration/damage of finishes. Paint areas of prefinished metal where finish is damaged; match color.

C. Prime soldered area of phosphatized metal after cleaning to prevent rusting.

D. Paint with aluminized paint, metal flashings that have been soiled with bitumen. Use medium nap roller to apply paint to surfaces to achieve monolithic finished color.

END OF SECTION 076205

SECTION 077234 - FORCED-ENTRY (FE) / BALLISTIC RESISTANT (BR) ROOF HATCHES

PART 1 - GENERAL

1.1 SUMMARY

A. The extent and location(s) of high-security roof hatches is indicated on Contract Drawings.

B. Related Sections include the following:

1. Section 055005 “Metal Fabrications” for stairs, ladders, and platforms to provide access to roof hatches.
2. Division 07 Sections for interfacing of roof hatches with roofing, insulation, flashing, and other components of the work.
3. Division 07 Sections for standard roof hatches.
4. Section 080001 “Blast Requirements”
5. Section 087155 “Security Door Hardware”; see requirements to Adjust and Clean.
6. **[Section 099602 “High Performance FEBR Coatings.”]**

1.2 PRE-INSTALLATION MEETINGS

A. Before beginning installation of FE/BR assemblies, the Contractor shall conduct a pre-installation conference at the Project site with installation sub-contractor, roofing sub-contractor, the Project Director/COR, and other interested parties to review installation procedures and manuals, schedules, and coordination of FE/BR-assembly installation with other elements of the Work.

1.3 ACTION SUBMITTALS

A. General:

1. Action submittals should be accepted by the PD/COR prior to procurement of associated items by Contractor; premature procurement is at the risk of Contractor.
2. Refer to Division 01 Section on Submittals for general administrative requirements.
3. All Action submittals shall be submitted together in one submission.

B. Product Data:

1. Product data for each element of work, whether purchased from other manufacturers or provided as hatch Fabricator's standard production to include hardware, weather-stripping, fasteners, gaskets, seals and accessary items. Include data substantiating that products comply with the requirements of this Section.

C. Shop Drawings: Shop drawings for each hatch unit. Provide plans, elevations, and sections at 1:20 scale. Provide details of fabrication, hatch seals, applied accessories, anchorages, and interfaces with adjoining and supporting construction at 1:5 scale. Include the following:

1. Cover sheet: Include manufacturer's name, address, telephone, and facsimile numbers; customer and address; project location; contract or purchase order number; and submittal release record.
2. Unit information:

    a. Manufacturers model number.
    b. Government DOS certification model number.
    c. DOS 4-digit code.
    d. Mark (hatch no.).
    e. Hatch/frame finish.
    f. Hatch type.

3. Elevation Drawings (in plan):

    a. Rough opening dimensions.
    b. Hatch opening dimensions.
    c. Frame opening dimensions.
    d. Substrate/rough opening material.
    e. Manufacturer's name and reference number for primer and finish paint, including number of coats applied.
    f. Separate steel sub-frames/embeds (number and list), where applicable.
    g. Detail symbols.
    h. Hardware and hardware symbols.
    i. Ladder or ships ladder integration

4. Section Drawings:

    a. Relate to sections and details on drawing.
    b. Identify "Attack" and "Protected" sides.

5. Details: Show section at 1:5 scale of members indicating construction, size, and thickness of components, frame profile, anchorage, steel sub-frames/embeds (where applicable), continuous shim plates (where applicable), location of conduit entry into both sub-frame and hatch frame, fastenings, shims, sealant, backer rods, and means of separating dissimilar metals and ladder/ship ladder details shall be on separate sheets from plan and elevation drawing.

    a. Sections through the curb (long and short direction) that shows dimensions of the curb, edge condition and all items protruding into the opening to include lifting devices, springs, and ladders.
    b. Details shall include contract drawing information of “products by others” such as flashing, ladders, and finishes surrounding the product.

        1) Details for flashing and weather proofing associated with Division 07, shall be coordinated with the weather proofing submittal/design and shall be shown for frame/roof curb condition.
        2) Details for the hatch shall be coordinated with safety rails, ladders, or ship ladders and shown in the drawings.

6. General Product Information: Include notes sheet, miscellaneous materials specifications, abbreviations, finish/paint system, and legend.

    a. Breakdown of Product Line Items: If Manufacturer produces one contract line item as several parts, they shall break out items on drawings. Each item shall be a subdivision of that product line-item number.

7. Coordination Drawings: provide coordination drawings with roof curb, roof weatherproof system, ladder, and Fall protection (as required).
8. Design Data including supporting calculations of each of the required performances.
9. Testing Laboratory Qualifications in accordance with the Part 1 Article on QUALITY ASSURANCE.
10. Shop finish samples for each required metal and finish showing required colors, textures and sheen; apply on 150mm lengths or squares of typical member shapes or plates used in the work.
11. Certificates: Letter from manufacturer indicating the products have been certified by Bureau of Diplomatic Security (DS) in accordance with the Part 2 Article on PERFORMANCE REQUIREMENTS.
12. Installation instructions customized for each type of application.

1.4 INFORMATIONAL SUBMITTALS

A. General:

1. Informational submittals shall be submitted at least four weeks prior to installation.
2. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Installer Qualification Data:

1. Submit resumes of all team lead installers (present and responsible for each install) documenting the installers conformance with experience requirements in accordance with the Part 1 Article on QUALITY ASSURANCE. Each resume shall include at least three references (including contract information) that can provide verification that the installer has the expertise required to perform a successful installation.
2. Submit manufacturers' certification to Project Director/COR for team lead installer indicating that she/he is capable of properly installing the FE/BR products, in accordance with the Part 1 Article on QUALITY ASSURANCE. The installer's qualifications require approval by OBO/CFSM/SM/SCD/SEB and OBO/OPS/FAC.

C. Qualification Data: For Manufacturer and Installer in accordance with the Part 1 Article on QUALITY ASSURANCE.

1.5 CLOSEOUT SUBMITTALS:

A. General:

1. Refer to Division 01 Sections on Submittals and on Closeout for general administrative requirements.

B. Special Warranty: Provide special warranty in accordance with the Part 1 Article on WARRANTY.

C. Maintenance Data:

1. Data shall include instructions for cleaning and maintenance.

D. Inspection Reports and Certificates of Compliance: See forms at end of this Section.

1. Provide Table of contents and/or bookmarks organizing by building and floor for each product using contract identification number.
2. Provide plan showing location of products (one plan may cover multiple products or whole floor if legible).
3. Provide completed Certificates of Compliance documenting that all FE/BR hatch assemblies have been installed in accordance with contract documents. Certificates of Compliance must be signed by the installation team leader and the General Contractors Quality Control.
4. Provide any additional QC documents used by Contractor during the installation.

1.6 QUALITY ASSURANCE

A. Quality Control for Forced-Entry/Ballistic Resistant (FE/BR) Products: Certify compliance of fabricated and assembled FE/BR products specified in this Section with each quality control procedure established by the Government; these procedures are identified in the Compliance Form at end of this Section. Other quality control forms are also found at end of this Section.

B. Testing Laboratory Qualifications: For compliance with non-security performance requirements on security hatch assemblies of this Section, use only those testing laboratories, which have successfully demonstrated to Project Director/COR that they have experience and capabilities needed to satisfactorily conduct required tests.

C. Installer Qualifications: Team lead installers (present and responsible for each install) shall have installed FE/BR hatch assemblies for a DOS project within last three years (minimum of five installed FE/BR or non-FE/BR roof hatches).

D. Pre-Installation:

1. Pre-Installation Conference: See Part 1 Article on PRE-INSTALLATION MEETINGS.

E. Installation Team Training: The Team leader (at no cost to the U.S. Government) shall provide the crew which is to actually perform installations of FE/BR assemblies with on-site, hands-on training to include installation of the entire assembly of the first FE/BR hatch. The Team leader shall also instruct the crew on preventive measures which must be taken to protect installers from injury and protect FE/BR assemblies from damage during construction.

F. Additional Assistance: Manufacturer's technical representative (at no cost to the U.S. Government) shall provide General Contractor any additional advice, instruction, or inspection required to enable General Contractor to complete installation certification in accordance with this Section.

G. Certification by General Contractor: Prior to final completion, the General Contractor shall provide to the Project Director/COR a certification that the FE/BR materials have been installed in accordance with the manufacturer's instructions, these specifications and are operational. Use Certificates of Compliance forms at end of this Section. Deviation from these requirements is only permitted with the written approval of the Project Director/COR with input from the OBO/CFSM/SM Physical Security Engineer, Designer of Record, and OBO/OPS/FAC. Specifically the General Contractor's certification shall include verification that:

1. The Installer team leader trained the installation crew and supervised the installation of the hatch.
2. Verify roof curb is installed square and rough opening is correct size.
3. Shim each bolt, as required; maintain minimum anchor embedment.
4. Ensure that hatches equipped with deadbolts turn freely without binding as applicable.
5. All temporary bolts have been replaced with permanent bolts.
6. All frame bolts have been torqued to meet the manufacturer’s specifications. Shims have been inserted at all bolt locations.
7. Frame bolts/screws shall comply with approved shop drawings.
8. All FE/BR product bolts, screws and anchors are metric products to the extent feasible.
9. Any cladding or removable covers that conceal the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cap plugs, cladding, and removable covers for each hatch have been tagged and won't be installed until after the final QA inspection has been conducted by the OBO/SEB representative.
10. At each hatch assembly, there is a consistent gap between the hatch leaf and the hatch frames.
11. All access plates for each hatch have been installed as indicated in the approved shop drawings.
12. Each hatch frame head has been installed level and the non- hinge side jamb has been installed plumb and square.
13. Each lockset fully engages and freely operates.
14. If applicable ballistic trim bars have been installed per the approved shop drawings.
15. The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers. One ID plate should be located on the hatch frame and one ID plate should be located under the hatch leaf.
16. Weather proofing and flashing is installed as shown on the approved shop drawings.

1.7 IDENTIFICATION SYSTEMS

A. Identify each assembly to provide Government with ready reference to original manufacturer to facilitate reorders, replacement parts, service, resolution of complaints, and inventory. Provide a label as an embossed/printed metal plate mechanically fastened to the frame and hatch for permanent identification. Locate ID label plate on the protected side, under the hatch edge at the hinge side of the base unit frame. The label shall be approximately 40 by 75 mm and shall cite:

1. Manufacturer's name/city/state.
2. Contract number.
3. Month/year of fabrication.
4. Mark number.
5. DOS model number. (Certification Number).
6. DOS Code.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roof hatch units to the project site prefabricated, prefinished, assembled, and equipped with accessory units to the greatest extent feasible. Ship hatch in export wood crates separate from any subframes/embeds (if applicable). Comply with the Government's criteria and manufacturer's recommendations for packaging, handling, storage, and delivery.

B. As applicable, clearly mark subframes with hatch mark number and identify jambs with “attack side”. Package subframes/embeds separate from the hatch assemblies. Protect each subframe/embed piece to minimize damage to finished surfaces.

C. Package and ship installation hardware (anchors, bolts, screws, shims, ballistic trim, shop drawings, etc.) for each hatch in the same crate as the hatch assembly.

D. Provide protection of pre-finished stainless steel finishes during delivery and on-site storage.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which the manufacturer agrees to repair or replace hatches that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Failure to meet performance requirements.
   b. Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
   c. Deterioration of metals, other materials, and metal finishes beyond normal weathering.
   d. Failure of hardware components.

2. Warranty Period:

   a. Hatches: Manufacturer shall warrant hatches for period of five years from substantial completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Fabricate and install FE/BR hatch assemblies to achieve indicated levels of resistance. Extend resistance to include anchorages, interfaces with adjoining substrates, and hardware.

B. Manufacturers must be certified by Bureau of Diplomatic Security (DS) in accordance with DS/PSP/PSD SD-STD-01.01, Rev H.

C. Certified Units: Provide units which are produced by manufacturer who has previously produced forced entry or ballistic hatches or doors or commercial roof hatches, within last 5 years, units of similar security attack resistances of equivalent size and resistance ratings, and which have been certified FE/BR products by Bureau of Diplomatic Security (DS) in accordance with DS/PSP/PSD SD-STD-01.01, Rev H.

D. DOS Hatch Codes: The following labels in Table 2.1, "Roof Hatch Codes" apply based upon the physical security resistance and fire rating associated with each hatch:

TABLE 2.1, "ROOF HATCH CODES"

DOS CODE	1st DIGIT - HATCH COMPO-SITION	2nd DIGIT - FIRE RATING	3rd DIGIT - FORCED-ENTRY RATING	4th DIGIT - BALLISTIC-RESISTANCE RATING
1	Transparent	None	None	None
2	Opaque	1.5 hours (class D at exterior)	15 minutes	Note Used
3	*	3 hours (class A)	60 minutes	Rifle 5.56 & 7.62 NATO
4	*	45 minutes (class C)	5 minutes	Armor-Piercing (.30-06)

Notes for above Table 2.1:

a. Composition - Column 1: Designated whether door has a transparency.
b. Fire Rating - Column 2: Fire-rated assemblies: Where indicated for fire resistance, provide flush steel Hatches-and-frame units; comply with NFPA 80, Standard for Fire Doors and Windows. Provide units that have been tested by recognized testing agency in accordance with NFPA No. 252 and ASTM E 152. Provide rated units where shown or as scheduled.
c. Forced Entry Rating - Column 3: Forced-Entry (FE) resistant assemblies: Where hatch assembly is shown, or scheduled as FE, provide door manufacturer's material and fabrication for panels, inserts, hardware, devices, and framing of units for the

above ratings by the Physical Security Division of the Bureau of Diplomatic Security (DS/PSP/PSD).

d. Ballistic Resistance Rating - Column 4: Ballistic resistant (BR) assemblies: Where hatch assembly is shown, or scheduled as BR, provide door manufacturer's materials and fabrication for panel, inserts, and framing of units for the above ratings by DS/PSP/PSD ratings.

E. Sound Transmission Class: Provide acoustical sound batt insulation, door gaskets and others to achieve an STC-50 rating. Acoustics shall be integrated into the design and not unduly complicate the operation of the hatch (i.e., no installing an additional hatch above or below the FE/BR hatch).

F. Design roof hatch lid to have a drip edge to direct water away from the hatch frame and onto the hatch flashing and finally to the roofing waterproofing system.

G. Wind Resistance: Force entry / ballistic resistant door assemblies shall withstand the effects of wind loads determined as follows, with no permanent deformation or breakage within door assembly when designed in according to ASCE 7-16, as adopted and amended by the OBO Building Code:

1. Basic Wind Speed: Shall be as indicated in the Structural Drawings.

H. Blast Resistance:

1. [Text prepared by a qualified and cleared blast consultant with project specific performance requirements or design shall either be inserted in this location or provided in a separate document and referenced in this location. Preference is for insertion in this location.]

2.2 MATERIALS, GENERAL

A. Stainless Steel: Sheets, Plates, Bars, Tubes, and shapes; Stainless Steel, Type 316, 2205 or 2101: ASTM A240M; low, moderate, and extreme ACL.

B. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics in any voids, not requiring TSS or in conflict with the door fasteners and latches or locks.

C. Hatch Gaskets: Provide primary sound reduction and weatherproof gasketing; provide special-performance secondary hatch seals where indicated. Hatch sound and weather gaskets shall be continuous around the opening. Refer to the Part 2 Article on PERFORMANCE REQUIREMENTS for sound requirements.

D. Shims: Provide 1.5 mm (1/16 inch) thick plastic shims with break-off tabs.

E. Inserts, Anchors, Bolts, Fasteners: Standard units of strengths required to endure performances; Stainless steel, grade shall match tested/certified condition. Provide compatible washer that prevents galvanic action.

1. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers: AISI Type 316 (Alloy Group 2), complying with ASTM F593 and ASTM A594, or ASTM A193 and ASTM A194, or ASTM A320 and ASTM A194; provide compatible AISI Type 316 washers where appropriate.
2. Anchors (Frame to Subframe/Substrate Attachment): Stainless steel, hot-dip, zinc-coated steel, or iron, complying with ASTM B 633 and ASTM F1941 for fasteners; provide sufficient mechanical properties to satisfy the specified performance requirements.
3. All anchors for hatches shall be metric (Class 8.8) equivalent to SAE J429 Grade 5 or other appropriate high strength bolts and hardened nuts and washers, or as needed to satisfy the performance requirements and comply with standard OBO specifications for FE/BR and Blast resistant products. In no case the strength of the bolt shall be less than the as tested condition. Contractor's design shall provide appropriate corrosion prevention where dissimilar metals are in close proximity and to address the atmospheric corrosion performance requirements identified in this specification

F. Butyl tape: Provide a layer of butyl tape between the concrete curb/roofing and roof hatch unit.

G. Curb: Design hatch to be used on a standard 600 mm (24 inches) concrete curb, measured from top of roof slab. If curb is not 600 mm (24") (e.g., renovation) the curb must be built up to 600 mm (24") with Stainless steel.

H. Hatch sleeve: Design hatch with a 500 mm (20 inches) extension sleeve from top of hatch roof curb into the roof opening with predrilled bolt slots.

2.3 HARDWARE AND DEVICES

A. General: Provide operating hardware, devices, and accessories, which will fulfill indicated level of safety and functional response to each form of attack or environmental impact, protect building and its occupancy with indicated level of security and will permit occupants to operate roof hatches in normal manner for access and exiting to roof.

B. Hardware: Provide locking hardware that is operated from the protected side of the hatch. No access hardware shall be provided on the attack side.

C. Lift Assist: Provide a primary and secondary lift assist system. (e.g., gas struts, springs, linear actuator, etc.).

D. Safety Rails: Provide an OSHA compliant 1067 mm (42 inches tall) safety railing/gate system anchored to the frame, not the roof, without compromising integrity of the hatch.

E. Design shall incorporate provision for either a ladder or ships ladder to be fastened directly to the hatch assembly. During coordination drawings development ensure conformance with all required clearances (e.g., head clearance).

2.4 FABRICATION AND ASSEMBLY

A. General: Fabricate to achieve performance requirements. Conform to Contract Drawings.

B. Stainless Steel: Fabricate units of stainless steel sheet of thicknesses indicated, but not less than 1.50 mm. Reinforce hatch and curb/well panels with welded-in-place ribs and edge channels of stainless steel. Reinforce work at hardware/device/accessory locations with welded stainless steel inserts. Provide stainless steel-sheet formed shapes for gasket housings, flashing reglets, and similar elements.

1. At Fabricator's option, equivalent strength aluminum extrusions may be substituted for formed steel-sheet shapes specified above.
2. Fabricate forced-entry resistant units of not-less-than 3.0 mm stainless steel-sheet exposed faces (on the attack side), and with non-removable, flush fastener heads and tightly covered/protected joints between hatches and curb/well. To the greatest extent practicable, locate hardware, devices, and accessories inside unit (on protected side).
3. Fabricate ballistic resistant units of stainless steel sheets/plates, with exposed faces of thickness, which has been certified to resist ballistics at specified ratings.

C. Provide stainless steel-sheet formed shapes for gasket housings, flashing reglets, and similar elements.

D. To the greatest extent practicable, prefabricate high security roof hatches at factory. Disassemble only to extent necessary for handling, delivery, and installation.

E. Hatch frames shall have pre-drilled horizontally slotted bolt-hole patterns not to exceed 300 mm on center.

F. Provide insulated, double-walled construction of hatches and well or curb of units.

G. Size: Hatch opening shall comply with model IBC and OSHA requirements for hatch clearances.

1. Hatch with Ladder: Standard size 770 (30-1/2 inches) x 940 (37 inches).
2. Hatch with Ship Ladder: Size must be dictated by design. Minimum dimensions 1000 mm (39-1/2 inches) x 1000 mm (39-1/2 inches).

H. Weld seams and grind smooth. Comply with AWS D1.6/D1.6M Latest year Structural Welding Code for Stainless Steel.

I. Hatch Door should overhang frame with a drip edge to run water away from the frame onto flashing away from hatch.

2.5 SHOP FINISHING

A. General: Apply finishes as indicated on approved Drawings. As applicable for risk associated with Atmospheric Corrosivity Level (ACL) for the project location. Refer to the Part 2 Article on CORROSION RESISTANCE PERFORMANCE for acceptable component materials for various ACL

B. [Stainless Steel: These components do not require coating, but may be coated for aesthetic purposes. See Section 099602 "High-Performance FE/BR Coatings" where coatings are applied.]

C. **[Fluoropolymer Coatings: Fluoropolymer coatings may be used over any acceptable base metal. See Section 099602 "High-Performance FE/BR Coatings."]**

2.6 ACCESSORIES

A. Fall Protection: Design roof hatch to accept fall protection railing above the roof level. It shall be capable of being installed directly to the roof hatch assembly and shall be removable if necessary using bolted fasteners. Comply with all requirements of OSHA 1910.29 and the model IBC for design of such railing to include not limited to height, railing size, rail spacing, load ratings, etc.

1. At the Contractor's option, the FE/BR roof hatch may incorporate a ladder or ships' ladder, designed by the Designer-of Record, to be fastened directly to the hatch assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to start of installation, inspect the building and verify all conditions and dimensions as being acceptable to receive the Work of this Section.

B. If any conditions are found that may inhibit proper execution of the Work, immediately notify the Project Director/COR in writing. Installation shall not proceed until remedial action, acceptable to the Project Director/COR, has been executed.

3.2 INSTALLATION

A. General: Install security hatch assemblies in accordance with approved shop drawings, manufacturer's data and instructions, and requirements of these specifications, and the checklists associated with attached Certificate of Compliance forms.

1. Install any fire rated assemblies in compliance with recommendations and instructions of SDI-100 and SDI-105.

a. At fire-rated openings, comply with NFPA 80.

2. Avoid cutting rebar during concrete sub-frame installation.
3. Install minimum one shim per bolt, for rough opening (RO) frame clearance.
4. Match finish of cap plugs used in frame with frame finish to the maximum extent possible. Do not install cap plugs until after the final QA inspection, conducted by an

OBO/CFSM/SM/SCD/SEB representative or another representative as designated by Project Director/COR, of the hatches has been completed.

B. Flashing: Install roof hatch and integrated flashing with roofing waterproofing systems in accordance with coordination drawings.

C. Anchorage:

1. The contractor shall verify substrates involved, and supply any special fastening tools (e.g., special drill, bit, tap) required by anchoring system.
2. The hatch manufacturer shall provide anchors appropriate for substrate to which frame and sub-frame is to be fastened. The anchor shall be acceptable for shock/short duration loading and have potential for removal and re-installation during life of building.

3.3 FIELD QUALITY CONTROL

A. Hatch installation team leader shall supervise installation crew during their installation of all FE/BR hatch. Upon completion of installation.

3.4 ADJUST AND CLEAN

A. Repair damaged elements, restore abraded surfaces, touch-up base-coat paint finish with air-drying primer and top finish coats in accordance with Section 099602 “High-Performance FE/BR Coatings,” and remove imperfections from exposed natural metal finishes.

B. Upon request of Project Director/COR, remove protective coverings, and clean exposed surfaces.

C. Check and readjust hardware, devices, and accessories with hatch-to-frame-and-sill/ threshold clearances set for proper operation of locks, hatch seals, and other operational units. Do not remove permanently applied performance labels.

3.5 DEMONSTRATION

A. The installation team leader (refer to the Part 1 Article on QUALITY ASSURANCE) shall fully train the Embassy staff in the proper operation and maintenance of the FE/BR hatch assemblies. This training shall be performed at no cost to the US government.

END OF SECTION 077234

Certificate of Compliance

FE/BR Roof Hatches
Hatch Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the FE/BR products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

DESCRIPTION – TRAINING/ SUPERVISION

1	The Installer team leader trained the installation crew and supervised the installation of the hatch.	**Installer Team Leader's Name/ Date:**

	DESCRIPTION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	Verify roof curb is installed square and rough opening is correct size.		
3	Shim each bolt, as required; maintain minimum anchor embedment		
4	Ensure that hatches equipped with deadbolts turn freely without binding as applicable.		
5	All temporary bolts have been replaced with permanent bolts		
6	All frame bolts have been torqued to meet the manufacturer's specifications. Shims have been inserted at all bolt locations.		
7	Frame bolts/screws shall comply with approved shop drawings.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
8	All FE/BR product bolts, screws and anchors are metric products to the extent feasible		
9	Any cladding or removable covers that conceal the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cap plugs, cladding, and removable covers for each hatch have been tagged and won't be installed until after the final QA inspection has been conducted by the OBO/SEB representative.		
10	At each hatch assembly, there is a consistent gap between the hatch leaf and the hatch frames		
11	All access plates for each hatch have been installed as indicated in the approved shop drawings.		
12	Each hatch frame head has been installed level and the non- hinge side jamb has been installed plumb and square.		
13	Each lockset fully engages and freely operates		
14	If applicable ballistic trim bars have been installed per the approved shop drawings.		
15	The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers. One ID plate should be located on the hatch frame and one ID plate should be located under the hatch leaf.		
16	Weather proofing and flashing is installed as shown on the approved shop drawings.		

Installer Team Lead:	**Contractor's QC Manager:**
Printed Name: _____	Printed Name: _____
Signature: _____	Signature: _____
Initials: _____	Initials: _____

Noted Variances:

_____

_____

_____

_____

_____

_____

DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

_____

_____

_____

_____

_____

[1 2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

U. S. DEPARTMENT OF STATE
OVERSEAS BUILDINGS OPERATIONS
GUIDE SPECIFICATIONS

2023-10-01

SECTION 080001 – BLAST REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes performance and design requirements, as well as administrative and procedural requirements for quality control and quality assurance as related to blast resistance requirements. Related specification sections include, but are not limited to the following:

1. Section 083454 Forced Entry (FE)/Ballistic Resistant (BR) Door Assemblies.
2. [Division 08 Section on Aluminum Window Walls & Windows.]
3. Section 084414 Structurally-Framed Security Curtain Wall System
4. Section 085651 Aluminum Security Windows
5. Section 085652 Aluminum Security Teller Windows.
6. Section 088855 Security Glazing.
7. Section 089117 Security Louvers.
8. [Division 08 Section on Fixed Non-Security Louvers.]

1.2 SUBMITTALS

A. Blast Report: Submit blast report containing blast environment and corresponding building design based on loads identified in Table 2.1 “Façade Blast Loads.” This report shall have a summary narrative, tabular summaries of member requirements and responses, design sketches and supporting calculations with their own table of contents. Discussion of ductile detailing for canopies and similar elements shall be included in the Blast Report. Incorporate methodology and requirements identified in OBO International Codes Supplements (OBO-ICS) to the International Building Code (IBC) Chapter 16. Blast Report and window shop drawings shall be submitted at the same time.

B. Design Calculations: Submit design analysis and calculations verifying conformance of ALL façade components to the specified blast criteria; such as glazing, mullions, steel plate assemblies, etc. All facade calculations that demonstrate the performance of the blast resistant facade must use the WINGARD software (no earlier than version PE 5.5.1) for determining the glass reaction forces and the industry standard of practice for performing dynamic response calculations. Calculation submittals shall be signed and sealed by a Registered Professional Engineer.

1. Loads imposed on Structure: All submitted calculations must clearly indicate the loads imposed on the supporting structure by the facade. Calculations shall indicate both the blast loads imposed and the conventional loads imposed separately.
2. Calculations shall use a consistent reference system and be coordinated with labeling system used on shop drawings.

C. Shop Drawings: Submit shop drawings signed and sealed by a Registered Professional Engineer, showing the proposed facade profiles and anchorages that demonstrate compliance with the design intent.

D. Qualification Data: Submit qualifications for window Subcontractors and Subcontractor's blast engineers verifying years of experience; include list of completed projects having similar scope of Work identified by name, location, date, reference names and phone numbers.

1.3 QUALITY ASSURANCE

A. Contractor/Subcontractor Qualifications.

1. A firm with documented, successful experience with work comparable to that specified in applicable components included in Part 2 of this Section.

B. Engineer Qualifications:

1. All calculations using dynamic 'blast loads' specified in terms of a peak pressure and impulse shall be performed by a Registered Professional Engineer having formal training in structural dynamics, and 5 years demonstrated experience with blast resistant design, determining dynamic loads, structural detailing, and dynamic response.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS, GENERAL

A. References:

1. Design and analysis referenced standards:

a. OBO International Codes Supplement (OBO-ICS) to the International Building Code (IBC); edition as identified in the project contract.
b. United Facilities Criteria (UFC), Design and Analysis of Hardened Structures to Conventional Weapons Effects, UFC 3-340-01.
c. United Facilities Criteria (UFC), Structures to Resist the Effects of Accidental Explosions, UFC 3-340-02.
d. U.S. General Services Administration, Window Glazing Analysis Response and Design, WINGARD, Technical Manual. Applied Research Associates, Inc. Vicksburg, MS, 2005

2. Unless otherwise noted, all requirements of UFC 3-340-02 and the OBO ICS IBC will be enforced.

B. Definitions:

1. Conventional Loads: Loads acting on façade elements defined by applicable building codes that are not blast loads. Conventional Loads include, but are not limited to wind, thermal and seismic loads.
2. Strength Increase Factor (SIF): An increase in design yield strength to account for the tendency of materials to have a yield strength capacity greater than the specified minimum.
3. Dynamic Increase Factor (DIF): An increase in design yield strength to account for the increase strain rates of a material under rapidly applied dynamic loading.

C. Delegated Design:

1. General: Provide delegated design services, submittals, shop drawings and calculations in conformance with the standards and references identified in this Section, and requirements identified in this Specification Section. The work in this Section requires delegated design services except for specific work that is specifically excluded. In addition, refer to other technical specification sections, Division 01 Sections, and general contract requirements regarding Delegated Design.

D. Blast Loads: Blast loads as identified in Table 2.1, “Façade Blast Loads.”. These shall be characterized by a linearly decaying pressure-time history defined by the given peak pressure and impulse. Negative phase effects shall not be considered. All glazing shall be designed for the following dynamic loading:

TABLE 2.1 – FAÇADE BLAST LOADS

Building	Facade	Level	Window Types	Pressure kPa (psi)	Impulse kPa -msec (psi-ms)
<Building A>	<North>	<L1 to roof>			
	<South>	<L2 to Lx>			
	<East>				
<Building B>	<North>				
	<East>				
<Building C>	<South>				

2.2 EXTERIOR GLASS AND WINDOW WALL BLAST DESIGN CRITERIA

A. General: All glass and window wall systems (frames, connections, anchorages, and other window hardware) shall be designed, fabricated, and installed to resist the applied blast loads defined in this section. All glass systems located directly in front of the blast resistant exterior concrete walls are exempt from these requirements. Refer to the Part 2 Article on EXTERIOR DOOR BLAST DESIGN CRITERIA for blast design requirements for glazing in doors and fixed glazing adjacent to doors such as transoms and sidelites.

B. Load Combinations: The dynamic blast pressures shall be considered as an independent load case and shall not be combined with wind or other design loads, with the exception of gravity; however, designing to meet the blast requirements does not eliminate the need to design the window systems to meet all other applicable loading conditions. The window system components are subject to compliance with all other conventional requirements and service loads.

C. The blast load used for the design of the provided window systems shall correspond to the blast loads at the location of the particular window, as identified in Table 2.1, "Façade Blast Loads."

D. Glass Performance Criteria: Design, fabricate, and install glass units to comply with the following:

1. Software:

a. Blast analysis of rectangular glazing shall be completed using the computer software WINGARD (no earlier than version PE 5.5.1), distributed by the General Services Administration. The recommended glazing parameters are identified in Table 2.2-1, "Glass and Laminate Material Properties."

b. For non-rectangular blast window openings, high fidelity Finite Element Analysis (FEA) modeling is required in order to investigate possible bite failure from the nonsymmetric glazing response. The following procedure specifies the minimum requirements that must be satisfied:

1) FEA Boundary Condition Criteria:

a) Window frame shall utilize rigid elements.
b) Glass bite modeled using actual dimensions. The captured bite shall account for the glass edge being held by the frame to resist displacements perpendicular to the plane of the window.
c) Glass shall not be directly attached to the frame and shall allow for any pull-out displacement.
d) Glass to frame (or gasket) interaction may account for friction.
e) Gaskets may be included and bonded to the frame but shall not be bonded to the glass.
f) Gasket preload is acceptable if documented as in accordance with field or manufacturer confirmed installation processes.

2) Calibration of FEA Model to Wingard:

a) Develop a Calibration FEA model to match Wingard performance:
b) Calibration FEA model for a <u>rectangular</u> opening shall match input parameters for the associated Wingard run (i.e. dimensions, bite, loading, and glass make-up).
c) Calibration FEA model shall use boundary condition criteria specified in section 1. Specifically, the boundary conditions integral to the Wingard development are not acceptable (in terms of symmetry, edge restraint, and shape of opening).

d) Tune the response of the FEA calibration to match the performance condition, maximum displacement, and predicted pull-out as they represent the type of physical results from tests that were used to validate Wingard and that are routinely observed or measured in blast tests.
e) GSA Condition 2 (cracked stays in frame) from Wingard results.
f) Maximum predicted inner lite displacement perpendicular to the glass.
g) Predicted pull-out in terms of glass edge node in-plane displacement.
h) Acceptable parameters for tuning include mesh size, element formulation, material properties, and friction at the frame (or gaskets if included).

3) Non-rectangular FEA Model:

a) Incorporate the parameters from the tuned FEA model and modify the geometry to match the shape of the non-rectangular window.
b) Non-rectangular model shall use boundary condition criteria specified in section 1.
c) A Friedlander pressure curve with negative phase is permissible.

2. Glass Hazard Level: Required glazing response under the design blast loading provided below. Where required per the project requirements and the OBO-ICS IBC, glazing layups must have a Forced Entry (FE) resistance rating and a Ballistic Resistance (BR) rating.

a. Glazing response shall be limited to Performance Condition 2 or better.

3. Sizing the glass layup and calculating glass edge reactions shall be computed as follows:

a. Probability of failure for sizing glazing layup:

1) Annealed Glass - 8 breaks per 1000 (static and dynamic).
2) Strengthened and Tempered Glass – 1 break per 1000 (static and dynamic).

b. Probability of failure for frame design:

1) All Glass – 750 breaks per 1000 (dynamic only; static probability of failure as specified for sizing glazing layup).
2) Frame design shall be designed for the highest edge shears between 1 break per 1000 (static and dynamic) and 750 breaks per 1000 (dynamic only).

c. The following material properties and probabilities of failure shall be used for the design of the glass.

TABLE 2.2-1 – GLASS AND LAMINATE MATERIAL PROPERTIES

Material Type	Annealed	Heat Strengthened	Fully Thermally Tempered	Polycarbonate	Polyvinyl Butyral (PVB)	Sentry-Guard (SG)
Young's Modulus, ksi	10,000	10,000	10,000	345	50.0	30.0
Poisson's Ratio	0.22	0.22	0.22	0.38	0.50	0.50
Elongation at Break	-	-	-	-	1.37	0.5
Unit Weight, pcf	155.5	155.5	155.5	69.1	65.7	58.8
Peak Stress corresponding to Pf, psi	4,000	7,600	16,000	9,500	3,500	4,000
Coefficient of Variation	0.28	0.15	0.10	0.15	-	-

4. Glazing retention: The glass unit retention system shall resist the blast loads specified in this section within limits and under conditions indicated.

   a. Glazing Bite: Provide a glazing bite engineered to resist the design blast loading. The basis of design is shown on the architectural drawings. Alternate bite details are acceptable if proven through engineering. Minimum frame bite shall be 25-mm.

E. Window Frame Performance Blast Design Criteria:

1. Design Methods: The performance of the window frames shall be demonstrated by one of the following methods:

   a. Inelastic dynamic structural analysis methods. Such analysis methods must be validated through comparison with explosive testing of similar components.
   b. Explosive testing. Explosive testing may be used for components or systems for which there are not validated analysis methods. Explosive testing methods are further defined in the major paragraph on "Blast Test Performance Requirements" within this Article on EXTERIOR GLASS AND WINDOW WALL BLAST DESIGN CRITERIA. Explosive testing is not mandatory.

2. Blast Loads: Window wall systems (frames, connections, anchorages, and other window hardware) shall be designed for the blast loads defined in Table 2.1, "Façade Blast Loads."
3. Window System Performance Criteria: Design and fabricate glazed window and window wall systems to comply with the following:

    a. Steel Window Frame Performance Criteria:

        1) Rotation (θ) and Ductility(μ): Window and window wall mullion end rotations and displacement ductility shall not exceed the following at the specified design blast loading:

            a) Mullion member over entire span: $\theta \leq 9°$ and $\mu \leq 15$.

    b. Aluminum Window Frame Performance Criteria:

        1) Rotation (θ) and Ductility(μ): Window and window wall mullion end rotations and displacement ductility shall not exceed the following at the specified design blast loading:

            a) For members where ultimate tensile strength is 10% higher than yield strength: $\theta \leq 9°$ and $\mu \leq 15$
            b) For members where ultimate tensile strength is NOT 10% higher than yield strength: $\mu \leq 1$

    c. All blast window frame design shall address, at a minimum, the response of axial effects on connections, stability and compression buckling of the mullions, and the potential for glazing and bite failure at the large response limits provided above.
    d. Rebound shall be considered in the design of the frame and anchorage system.
    e. Components: Design window and window wall mullions and frames using the expected dynamic yield strength of their respective materials. Expected dynamic yield strength shall account for SIF and DIF as defined in Table 2.2-2, "Material Enhancement Factors."
    f. Metal Shapes and Extrudes:

        1) Material Enhancement Factors: Material properties shall be enhanced with the applicable factors listed in Table 2.2-2, "Material Enhancement Factors.". These factors shall be applied to the yield stress for the members. These dynamic enhancement factors do not apply to connection design.

TABLE 2.2-2 – MATERIAL ENHANCEMENT FACTORS

Material	Grade	SIF	DIF
Aluminum	6061-T6	1.14	1.02
Aluminum	6063-T6	1.24	1.02
Steel	A992, A500 Gr. B, A572 Gr. 50, or Equivalent	1.05	1.19
Steel	A36, or Equivalent	1.10	1.29

2) If aluminum extrusion and steel are both assumed to contribute to blast resistance, the steel and the aluminum mullions shall be designed as combined or composite sections as defined below:

   a) Composite section properties of mullion components may only be used if calculations demonstrate strain compatibility across the interface between the aluminum and steel components.
   b) Combined section properties of mullion components may be used if calculations demonstrate deformation compatibility across the interface between the aluminum and steel components.

3) Snap on elements or other aluminum extrusions that are not structurally connected together to act as a single composite member under blast deformations shall not be considered in determining the structural capacity of the mullion.

4. Anchorage and Connection Design: The glazed aluminum window and window wall system anchorages shall be designed, fabricated, and installed to meet the conditions specified in this Section within limits and under conditions indicated.

   a. Reaction Forces: Connections to the structure shall be engineered for the calculated reaction forces of the specified design load of the window and window wall framing members.
   b. Contractor to be responsible for coordination of window anchorage hardware and the supporting structure.
   c. Design anchorages and connections as per the latest versions of AISC LRFD manuals for steel connections, the latest version of the Aluminum Design Manual for aluminum connections, and the latest version of ACI-318 or PCI Design Handbook for anchorage to concrete. Where detailing is partially or completely out

of the scope of ACI-318, supplement the principles laid out in this document with rational engineering and industry-accepted principles of mechanics or documented design methodologies approved by the Project Director/COR. Clearly document all assumptions used for the design of the anchorages and connections for review by the design team.

1) Load factor for blast reactions shall be 1.0.
2) Resistance factors specified in the noted design manuals shall be used to design applicable components.
3) Where a resistance factor is not specified or an LRFD code does not apply, use a resistance factor of 0.67 on the ultimate strength of the component.
4) Anchor/breakout reinforcing shall be designed as required by embed design.

F. Blast Test Performance Requirements: Performance of exterior windows and window wall systems may be demonstrated through blast testing that complies with the performance criteria described below.

1. Test results for system assemblies similar to the exterior windows and window wall systems provided for this Project. These test results shall be supported by calculations, subject to the requirements herein.

   a. The Blast Consultant for this Project shall determine the applicability of the test results for the similar window system assemblies.

2. Testing methods shall adhere to ASTM F1642.
3. OBO reserves the right to reject test data considered insufficient.

G. Unless otherwise noted, all requirements of UFC 3-340-02 and the 2019 OBO Design Standards shall be enforced.

2.3 EXTERIOR METAL WINDOW WALL INFILL PANEL BLAST DESIGN CRITERIA

A. General: Exterior non-glazed metal infill panels, that are supported by the exterior window wall systems, shall be designed, fabricated, and installed to resist the applied blast loads defined in this section, preferably by the window wall subcontractor. Non-glazed surfaces located along the exterior facade shall be designed for blast. The Contractor is responsible for the final design and coordination of all delegated design items, including any metal infill plates or panels required to meet blast and/or FE/BR requirements. This includes metal closure plate assemblies (plates, tubes, welds, bolts, embed plate, etc.) at the boundary of the exterior façade and adjacent the concrete walls.

B. Load Combinations: The dynamic blast pressures shall be considered as an independent load case and shall not be combined with wind or other design loads, with the exception of gravity; however, designing to meet the blast requirements does not eliminate the need to design the non-glazed surfaces to meet all other applicable loading conditions.

C. The blast load used for the design of the provided infill panels shall correspond to the location of the particular panel, as identified in Table 2.1, "Facade Blast Loads."

D. Performance Criteria: Design, fabricate, and install non-glazed units to comply with the following with the aluminum or steel performance requirements listed below:

1. Aluminum non-glazed components with ultimate tensile strength greater than 10% of the yield strength.

   a. End rotation shall not exceed: $\theta \leq 9°$ and $\mu \leq 15$.

2. Steel non-glazed components.

   a. Steel plate shall not exceed an end rotation of $\theta \leq 10°$ and $\mu \leq 30$.
   b. Steel studs, with yield strength less than 33 ksi, or steel section supporting non-glazed surfaces shall not exceed end rotation of $\theta \leq 9°$ and $\mu \leq 20$ for a linear displaced shape.

3. Connections shall be design per the requirements listed in connections subparagraph in the major paragraph on "Window Frame Performance Blast Design Criteria" in the Part 2 Article on EXTERIOR GLASS AND WINDOW WALL BLAST DESIGN CRITERIA.

2.4 EXTERIOR DOOR BLAST DESIGN CRITERIA

A. All exterior doors located within a blast-resistant building envelope shall satisfy blast requirements specified in Section 083454 "FE/BR Door Assemblies."

PART 3 - EXECUTION (NOT USED)

END OF SECTION 080001

SECTION 081115 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes doors which do not have FE/BR requirements:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.
3. Interior custom hollow-metal doors and frames.
4. Exterior custom hollow-metal doors and frames.

B. Related Requirements:

1. Section 083454 “FE/BR Door Assemblies.”
2. Section 087135 "Non-Security Door Hardware" for door hardware for hollow-metal doors.
3. Division 08 Section on general “Glazing” for glass view panels in hollow metal doors.
4. Division 09 Sections for painting and coatings.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, **[fire-resistance ratings,] [temperature-rise ratings,]** and finishes.

B. Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

D. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 100-mm- (4-inch-) high wood blocking. Provide minimum 6-mm (1/4-inch) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings**[and temperature-rise limits]** indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide assemblies with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2. [Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.]

3. Temperature-Rise Limit: **[Where indicated] [At vertical exit enclosures and exit passageways]**, provide doors that have a maximum transmitted temperature end point of not more than 250 deg C (450 deg F) above ambient after 30 minutes of standard fire-test exposure.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than **[2.84 W/K x sq. m** (0.50 deg Btu/F x h x sq. ft.)**] [2.27 W/K x sq. m** (0.40 deg Btu/F x h x sq. ft.)**] [2.16 W/K x sq. m** (0.38 deg Btu/F x h x sq. ft.)**] <Insert U-factor>** when tested according to ASTM C 518.

2.2 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Standard-Duty Doors and Frames: SDI A250.8, Level 1; SDI A250.4, Level C. **[At locations indicated in the Door and Frame Schedule]** <**Insert locations**>.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: **[45 mm** (1-3/4 inches)**] [35 mm** (1-3/8 inches)**]**.
c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 0.8 mm (0.032 inch).
d. Edge Construction: **[Model 1, Full Flush] [Model 2, Seamless]**.
e. Core: **[Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener]**.
f. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated]**doors.

2. Frames:

a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.0 mm (0.042 inch).
b. **[Sidelite] [and] [Transom]** Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Full profile welded.

3. Exposed Finish: Prime.

C. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B. **[At locations indicated in the Door and Frame Schedule]** <**Insert locations**>.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.0 mm (0.042 inch).
d. Edge Construction: **[Model 1, Full Flush] [Model 2, Seamless]**.
e. Core: **[Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener]**.
f. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated]**doors.

2. Frames:

a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.3 mm (0.053 inch).
b. **[Sidelite] [and] [Transom]** Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Full profile welded.

3. Exposed Finish: Prime.

D. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3; SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule]** <**Insert locations**>.

1. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 45 mm (1-3/4 inches).
   c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.3 mm (0.053 inch).
   d. Edge Construction: **[Model 1, Full Flush] [Model 2, Seamless] [Model 3, Stile and Rail]**.
   e. Core: **[Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener]**.
   f. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener] [laminated mineral board] core for fire-rated [and temperature-rise-rated]**doors.

2. Frames:

   a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.3 mm (0.053 inch).
   b. **[Sidelite] [and] [Transom]** Frames: Fabricated from same thickness material as adjacent door frame.
   c. Construction: Full profile welded.

3. Exposed Finish: Prime.

E. Maximum-Duty Doors and Frames: SDI A250.8, Level 4; SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule]** <**Insert locations**>.

1. Doors:

   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 45 mm (1-3/4 inches).
   c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.7 mm (0.067 inch).
   d. Edge Construction: **[Model 1, Full Flush] [Model 2, Seamless]**.
   e. Core: **[Manufacturer's standard] [Kraft-paper honeycomb] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener]**.
   f. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener] [laminated mineral board]** core for fire-rated **[and temperature-rise-rated]**doors.

2. Frames:

   a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.7 mm (0.067 inch).
   b. **[Sidelite] [and] [Transom]** Frames: Fabricated from same thickness material as adjacent door frame.
   c. Construction: Full profile welded.

3. Exposed Finish: Prime.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B. **[At locations indicated in the Door and Frame Schedule]** <**Insert locations**>.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: Metallic-coated steel sheet, minimum thickness of 1.0 mm (0.042 inch), with minimum **[ZF120 (A40)] [ZF180 (A60)]**coating.
d. Edge Construction: **[Model 1, Full Flush] [Model 2, Seamless]**.
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors**[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: **[Manufacturer's standard] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener]**.
h. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener with insulation] [laminated mineral board]** core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 1.3 mm (0.053 inch), with minimum **[ZF120 (A40)] [ZF180 (A60)]**coating.
b. Construction: Full profile welded.

3. Exposed Finish: Prime.

C. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3; SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule]** <**Insert locations**>.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: Metallic-coated steel sheet, minimum thickness of 1.3 mm (0.053 inch), with minimum **[ZF120 (A40)] [ZF180 (A60)]**coating.
d. Edge Construction: **[Model 1, Full Flush] [Model 2, Seamless] [Model 3, Stile and Rail]**.
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.

f. Bottom Edges: Close bottom edges of doors**[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: **[Manufacturer's standard] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener]**.
h. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener with insulation] [laminated mineral board]** core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 1.3 mm (0.053 inch), with minimum **[ZF120 (A40)] [ZF180 (A60)]** coating.
b. Construction: Full profile welded.

3. Exposed Finish: Prime.

D. Maximum-Duty Doors and Frames: SDI A250.8, Level 4; SDI A250.4, Level A. **[At locations indicated in the Door and Frame Schedule]** <**Insert locations**>.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: Metallic-coated steel sheet, minimum thickness of 1.7 mm (0.067 inch), with minimum **[ZF120 (A40)] [ZF180 (A60)]** coating.
d. Edge Construction: **[Model 1, Full Flush] [Model 2, Seamless]**.
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors**[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: **[Manufacturer's standard] [Polystyrene] [Polyurethane] [Polyisocyanurate] [Vertical steel stiffener]**.
h. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener with insulation] [laminated mineral board]** core for fire-rated doors.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 1.7 mm (0.067 inch), with minimum **[ZF120 (A40)] [ZF180 (A60)]** coating.
b. Construction: Full profile welded.

3. Exposed Finish: Prime.

2.4 INTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Hollow-Metal Doors and Frames: NAAMM-HMMA 860; SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule] <Insert locations>**.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of **[0.8 mm (0.032 inch)] [1.0 mm (0.042 inch)] [1.3 mm (0.053 inch)]**.
d. Edge Construction: **[Continuously welded with no] [Projection or tack welded with no] [Interlocking with] [Projection or tack welded with]** visible seam.
e. Core: Steel stiffened.
f. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener] [laminated mineral board]** core for fire-rated **[and temperature-rise-rated]**doors.

2. Frames:

a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.3 mm (0.053 inch).
b. **[Sidelite] [and] [Transom]** Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: **[Knocked down] [Slip-on drywall] [Face welded] [Full profile welded]**.

3. Exposed Finish: Prime.

B. Commercial Doors and Frames: NAAMM-HMMA 861; SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule] <Insert locations>**.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.0 mm (0.042 inch).
d. Edge Construction: Continuously welded with no visible seam.
e. Core: Steel stiffened.
f. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener] [laminated mineral board]** core for fire-rated [and temperature-rise-rated]doors.

2. Frames:

a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.3 mm (0.053 inch), except 1.7 mm (0.067 inch) for openings exceeding1219 mm (4 feet) wide.

b. **[Sidelite] [and] [Transom]** Frames: Fabricated from same material as adjacent door frame.
c. Construction: **[Face] [Full profile]** welded.

3. Exposed Finish: Prime.

C. Commercial Laminated Doors and Frames: NAAMM-HMMA 867; SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule] <Insert locations>**.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of **[0.8 mm (0.032 inch)] [1.0 mm (0.042 inch)] [1.3 mm (0.053 inch)]**.
d. Edge Construction: **[Continuously welded with no visible seam] [Interlocking with visible seam] [Interlocking with no visible seam] [Projection, spot, or tack welded with or without visible seams]**.
e. Edge Bevel: **[Bevel lock and hinge edges 3.2 mm in 50 mm (1/8 inch in 2 inches)] [Bevel lock edge 3.2 mm in 50 mm (1/8 inch in 2 inches)]**.
f. Core: **[Kraft-paper honeycomb] [Polyisocyanurate] [Polystyrene] [Polyurethane] [Vertical steel stiffener]**.
g. Fire-Rated Core: Manufacturer's standard **[vertical steel stiffener] [laminated mineral board]** core for fire-rated **[and temperature-rise-rated]**doors.

2. Frames:

a. Materials: **[Uncoated] [Metallic-coated]** steel sheet, minimum thickness of 1.3 mm (0.053 inch).
b. **[Sidelite] [and] [Transom]** Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: **[Knocked down] [Slip-on drywall] [Face welded] [Full profile welded]**.

3. Exposed Finish: **[Prime] [Unprimed]**.

2.5 EXTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Commercial Doors and Frames: NAAMM-HMMA 861; SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule] <Insert locations>**.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).

c. Face: Metallic-coated steel sheet, minimum thickness of 1.30 mm (0.053 inch), with minimum **[ZF120 (A40)] [ZF180 (G60 or A60)]** coating.
d. Edge Construction: Continuously welded with no visible seam.
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors**[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: Steel stiffened.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 1.3 mm (0.053 inch), except 1.7 mm (0.067 inch) for openings exceeding1200 mm (4 feet) wide; with minimum **[ZF120 (A40)] [ZF180 (G60 or A60)]** coating.
b. Construction: Full profile welded.

3. Exposed Finish: Prime.

B. Commercial Laminated Doors and Frames: NAAMM-HMMA 867; SDI A250.4, Physical Performance Level A. **[At locations indicated in the Door and Frame Schedule] <Insert locations>**.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 45 mm (1-3/4 inches).
c. Face: Metallic-coated steel sheet, minimum thickness of **[1.3 mm (0.053 inch)] [1.0 mm (0.042 inch)]**, with minimum **[ZF120 (A40)] [ZF180 (G60 or A60)]** coating.
d. Edge Construction: **[Continuously welded with no visible seam] [Interlocking with visible seam] [Interlocking with no visible seam] [Projection, spot, or tack welded with or without visible seams]**.
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors**[where required for attachment of weather stripping]** with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
g. Core: **[Kraft-paper honeycomb] [Polyisocyanurate] [Polystyrene] [Polyurethane] [Vertical steel stiffener]**.

2. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 1.3 mm (0.053 inch), with minimum **[ZF120 (A40)] [ZF180 (G60 or A60)]** coating.
b. Construction: **[Knocked down] [Face welded] [Full profile welded]**.

3. Exposed Finish: **[Prime] [Unprimed]**.

2.6 BORROWED LITES

A. Fabricate of **[uncoated] [metallic-coated]** steel sheet, minimum thickness of **[1.3 mm (0.053 inch)] [1.0 mm (0.042 inch)]**.

B. Construction: **[Knocked down] [Face welded] [Full profile welded]**.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.7 HOLLOW-METAL PANELS

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.8 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 600 mm (24 inches) of frame height above 2.1 m (7 feet).
3. Postinstalled Expansion Anchor: Minimum 10-mm- (3/8-inch-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 50-mm (2-inch) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A 879/A 879M, Commercial Steel (CS), 12G (04Z) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M; hot-dip galvanized according to ASTM A 153/A 153M, Class B.

2.9 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25]** <**Insert value**> percent.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

H. Glazing:

1. Factory install glazing in doors.
2. Buildings Subject to Blast Requirements: Glazing in doors shall use laminated tempered glass or laminated heat-strengthened glass, minimum thickness of 12-mm for laminated portion, with 25-mm frame bite. For doors with insulated glass, laminated portion shall be on interior (protected) side of building. Refer to OBO-ICS IBC Section 422.
3. In addition, comply with requirements in Division 08 general “Glazing” Section.

2.10 FABRICATION

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 19 mm (3/4 inch) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. **[Sidelite] [and] [Transom Bar]** Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with **[butted] [or] [mitered]** hairline joints.

1. Provide stops and moldings flush with face of door, and with **[beveled] [square]** stops unless otherwise indicated.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 225 mm (9 inches) o.c. and not more than 50 mm (2 inches) o.c. from each corner.

2.11 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

    a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.**[Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.]**
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

    a. Squareness: Plus or minus 1.6 mm (1/16 inch), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

b. Alignment: Plus or minus 1.6 mm (1/16 inch), measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1.6 mm (1/16 inch), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1.6 mm (1/16 inch), measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

D. Glazing: Comply with installation requirements in Division 08 Section on "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION 081115

SECTION 081415 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-core doors with **[wood-veneer] [MDO] [hardboard or MDF] [and] [plastic-laminate]** faces.
2. Hollow-core doors with **[wood-veneer] [hardboard or MDF] [and] [plastic-laminate]** faces.
3. **[Shop priming] [Factory finishing]** flush wood doors.
4. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. **[Section 062025 "Interior Finish Carpentry] [Section 064023 "Interior Architectural Woodwork"]** for wood door frames**[including fire-rated wood door frames]**.
2. Division 06 Section "Flush Wood Paneling" for requirements for veneers from the same flitches for both flush wood doors and flush wood paneling.
3. Division 08 Section on general "Glazing" for glass view panels in flush wood doors.
4. Division 08 Section “Wood Sound Control Door Assemblies” for acoustically rated wood door application.
5. Section 087135 “Non-Security Door Hardware.”
6. Division 09 Sections on painting, coatings, and finishing for field finishing doors.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction**[, louvers,]** and trim for openings.**[Include factory-finishing specifications.]**

B. Sustainable Design Submittals:

1. Product Certificates: For materials manufactured within 150 km (100 miles) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

D. Samples:

1. Factory finishes applied to actual door face materials, approximately 200 by 250 mm (8 by 10 inches), for each material and finish**.[For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.]**
2. Plastic laminate, 150 mm (6 inches) square, for each color, texture, and pattern selected.
3. Louver blade and frame sections, 150 mm (6 inches) long, for each material and finish specified.
4. Frames for light openings, 150 mm (6 inches) long, for each material, type, and finish required.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Mark each door on bottom rail with opening number used on Shop Drawings.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

PART 2 - PRODUCTS

2.1 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with [AWI's, AWMAC's, and WI's "Architectural Woodwork Standards] [WDMA I.S.1-A, "Architectural Wood Flush Doors]."

1. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.

B. Regional Materials: Wood doors shall be manufactured within 100 miles (150 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

C. Certified Wood: Wood doors shall be certified as "FSC Pure"**[or "FSC Mixed Credit"]** according to FSC STD-01-001 and FSC STD-40-004.

D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

F. WDMA I.S.1-A Performance Grade:

1. Heavy Duty unless otherwise indicated.
2. Extra Heavy Duty: **[Gathering and Classrooms] [representational and PAA and community use toilets][Non-corridor workrooms adjacent to enclosed offices with wood] [and] [patient rooms][and where indicated]**.
3. Standard Duty: **[Enclosed offices where scheduled as wood][Representational and PAA closets][Inside Residential dwelling unit interior doors] [and where indicated]**.

G. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Temperature-Rise Limit: **[Where indicated] [At vertical exit enclosures and exit passageways]**, provide doors that have a maximum transmitted temperature end point of not more than 250 deg C (450 deg F) above ambient after 30 minutes of standard fire-test exposure.
3. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
4. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
5. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

H. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

I. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, **[Grade LD-1] [or] [Grade LD-2]**.
2. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
3. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
4. Provide doors with **[glued-wood-stave] [or] [structural-composite-lumber]** cores instead of particleboard cores for doors indicated to receive exit devices.

J. Structural-Composite-Lumber-Core Doors:

1. Structural Composite Lumber: WDMA I.S.10.

   a. Screw Withdrawal, Face: 3000 N (700 lbf).
   b. Screw Withdrawal, Edge: 1800 N (400 lbf).

K. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

L. Hollow-Core Doors:

1. Construction: **[Institutional] [Standard]** hollow core.

2. Blocking: Provide wood blocking with minimum dimensions as follows:

   a. 125-by-450-mm (5-by-18-inch) lock blocks at both stiles.
   b. 250-mm (5-inch) top- and bottom-rail blocking.
   c. 64 mm (2-1/2-inch) midrail blocking.

2.2 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors <**Insert drawing designation**>:

1. Grade: **[Premium, with Grade AA faces] [Premium, with Grade A faces] [Custom (Grade A faces)] [Custom (Grade B faces)]**.

2. Species: **[Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] <Insert species>**.

3. Cut: **[Rotary cut] [Plain sliced (flat sliced)] [Quarter sliced] [Rift cut]**.

4. Match between Veneer Leaves: **[Book] [Slip] [Pleasing]** match.

5. Assembly of Veneer Leaves on Door Faces: **[Center-balance] [Balance] [Running]** match.
6. Pair and Set Match: Provide for doors hung in same opening**[or separated only by mullions]**.

7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by **[3 m (10 feet)] [6 m (20 feet)]** <**Insert dimension**> or more.
8. Exposed Vertical Edges: Same species as faces or a compatible species - edge Type A.
9. Core: **[Particleboard] [Glued wood stave] [Structural composite lumber] [Either glued wood stave or structural composite lumber] [Either glued or nonglued wood stave or structural composite lumber]**.
10. Construction: **[Five] [Five or seven]** plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.

B. Interior Hollow-Core Doors <**Insert drawing designation**>:

1. Grade: **[Premium, with Grade AA faces] [Premium, with Grade A faces] [Custom (Grade A faces)] [Custom (Grade B faces)]**.

2. Species: **[Anigre] [Select white ash] [Figured select white ash] [Select white birch] [Select red birch] [Cherry] [Select red gum] [Figured select red gum] [Select white maple] [Red oak] [White oak] [Persimmon] [Sapele] [Sycamore] [Walnut] <Insert species>**.

3. Cut: **[Rotary cut] [Plain sliced (flat sliced)] [Quarter sliced] [Rift cut]**.

4. Match between Veneer Leaves: **[Book] [Slip] [Pleasing]** match.

5. Assembly of Veneer Leaves on Door Faces: **[Center-balance] [Balance] [Running]** match.
6. Pair and Set Match: Provide for doors hung in same opening**[or separated only by mullions]**.
7. Exposed Vertical Edges: Same species as faces or a compatible species - edge Type A.
8. Construction: Seven plies.

2.3 DOORS FOR OPAQUE FINISH

A. Interior Solid-Core Doors <**Insert drawing designation**>:

1. Grade: **[Premium] [Custom]**.

2. Faces: **[MDO] [Any closed-grain hardwood of mill option] [Hardboard or MDF]**.

a. Apply MDO to **[standard-thickness, closed-grain, hardwood face veneers] [or] [directly to high-density hardboard crossbands]**.
b. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).

3. Exposed Vertical**[and Top]** Edges: Any closed-grain hardwood.
4. Core: **[Particleboard] [Glued wood stave] [Structural composite lumber] [Either glued wood stave or structural composite lumber] [Either glued or nonglued wood stave or structural composite lumber]**.
5. Construction: **[Three] [Five] [Five or seven]** plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.**[Faces are bonded to core using a hot press.]**
6. Construction: **[Three] [Seven]** plies, either bonded or nonbonded.

B. Interior Hollow-Core Doors <**Insert drawing designation**>:

1. Grade: **[Premium] [Custom]**.
2. Faces: **[Any closed-grain hardwood of mill option] [Hardboard or MDF]**.

a. Hardboard Faces: ANSI A135.4, Class 1 (tempered) or Class 2 (standard).
b. MDF Faces: ANSI A208.2, Grade 150 or Grade 160.

3. Exposed Vertical**[and Top]** Edges: Any closed-grain hardwood.

2.4 PLASTIC-LAMINATE-FACED DOORS

A. Interior Solid-Core Doors

1. Grade: **[Premium] [Custom]**.

2. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, **[Grade HGS] [Grade HSH]**.
3. Colors, Patterns, and Finishes: **[As indicated] [As selected by Project Director/COR from laminate manufacturer's full range of products]**.
4. Exposed Vertical Edges: **[Hardwood edges for staining to match faces] [Hardwood edges for painting] [Plastic laminate that matches faces, applied before faces]**.
5. Core: **[Particleboard] [Glued wood stave] [Structural composite lumber] [Either glued wood stave or structural composite lumber]**.

6. Construction: Three plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before faces are applied.**[Faces are bonded to core using a hot press.]**
7. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before faces and crossbands are applied.**[Faces are bonded to core using a hot press.]**

B. Interior Hollow-Core Doors <**Insert drawing designation**>:

1. Grade: **[Premium] [Custom]**.

2. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, **[Grade HGS] [Grade HSH]**.
3. Colors, Patterns, and Finishes: **[As indicated] [As selected by Project Director/COR from laminate manufacturer's full range of products]**.
4. Exposed Vertical Edges: **[Hardwood edges for staining to match faces] [Hardwood edges for painting] [Plastic laminate that matches faces, applied before faces]**.

2.5 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: **[Same species as door faces] [Species compatible with door faces] [Any closed-grain hardwood]**.
2. Profile: **[Flush rectangular beads] [Recessed tapered beads] [Recessed tapered beads with exposed banding] [Lipped tapered beads] [Manufacturer's standard shape]**.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

C. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch-1.2-mm- thick, cold-rolled steel sheet; **[factory primed for paint] [with baked-enamel- or powder-coated]** finish; and approved for use in doors of fire-protection rating indicated.

D. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.

1. Wood Species: **[Same species as door faces] [Species compatible with door faces] [Any closed-grain hardwood]**.

E. Metal Louvers:

1. Blade Type: **[Vision-proof, inverted V] [Vision-proof, inverted Y] [Darkroom-type, double inverted V]**.
2. Metal and Finish: Hot-dip galvanized steel, 1.0 mm (0.040 inch) thick, **[factory primed for paint] [with powder-coated]** finish.

F. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.

1. Metal and Finish: Hot-dip galvanized steel, 1.0 mm (0.040 inch) thick, **[factory primed for paint] [with powder-coated]** finish.

2.6 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

1. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.

1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.

1. Fabricate door and transom panels with full-width, solid-lumber**[, rabbeted,]** meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing:

a. Buildings Subject to Blast Requirements: Glazing in doors shall use laminated tempered glass or laminated heat-strengthened glass, minimum thickness of 12-mm for laminated portion, with 25-mm frame bite. For doors with insulated glass, laminated portion shall be on interior (protected) side of building. Refer to OBO-ICS IBC Section 422.
b. Factory install glazing in doors
c. In addition, comply with applicable requirements in Division 08 Section on general "Glazing."

3. Louvers: Factory install louvers in prepared openings.

2.7 SHOP PRIMING

A. Doors for Opaque Finish: Shop prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in **[Division 09 Section on "Exterior Painting."] [Division 09 Section on "Interior Painting."]**

2.8 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Factory finish doors where indicated in schedules or on Drawings as factory finished.

C. Transparent Finish:

1. Grade: **[Premium] [Custom]**.

2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" **[System 5, conversion varnish] [System 9, UV curable, acrylated epoxy, polyester, or urethane] [System 10, UV curable, water based] [or] [System 11, catalyzed polyurethane] <Insert finish designation>**.
3. Staining: **[Match Project Director/COR's sample] [As selected by Project Director/COR from manufacturer's full range] [None required]**.

4. Effect: **[Open-grain finish] [Filled finish] [Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores]**.
5. Sheen: **[Satin] [Semigloss]**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Section 087135 "Non-Security Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

1. Install fire-rated doors according to NFPA 80.
2. Install smoke- and draft-control doors according to NFPA 105.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 3.2 mm (1/8 inch) at heads, jambs, and between pairs of doors. Provide 3.2 mm (1/8 inch) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide1/4 inch6.4 mm from bottom of door to top of threshold unless otherwise indicated.

a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 3.2 mm in 50 mm (1/8 inch in 2 inches) 3-1/2 degrees at lock and hinge edges.

3. Bevel fire-rated doors 3.2 mm in 50 mm (1/8 inch in 2 inches) 3-1/2 degrees at lock edge; trim stiles and rails only to extent permitted by labeling agency.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081415

SECTION 083115 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

B. Related Requirements:

1. Division 07 Sections for roof hatches.
2. Section 083454 "Forced-Entry Resistant (FE) and Ballistic Resistant (BR) Door Assemblies" for access doors and frames for security applications.
3. Section 087135 “Non-Security Door Hardware.”
4. Division 09 Section(s) on painting.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details **[, fire ratings,]** material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 150 by 150 mm in size.

C. Product Schedule: For access doors and frames.**[Use same designations indicated on Drawings.]**

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection**[and temperature-rise limit]** ratings indicated, according to NFPA 252 or UL 10B.

B. See OBO Building Code Chapter 4 for limitations on the use of access doors for security.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges **<for Concrete or Masonry>**:

1. Description: Face of door flush with frame, with exposed flange and concealed piano hinge.
2. Locations: **[Wall] [Ceiling] [Wall and ceiling]**.
3. Uncoated Steel Sheet for Door: **[Nominal 1.52 mm , 16 gage]**, factory **[primed] [finished]**.
4. Frame Material: **[Same material, thickness, and finish as door]**.
5. Latch and Lock: Cam latch, key operated.

B. Flush Access Doors with Exposed Flanges <for Tile>:

1. Description: Face of door flush with frame, with exposed flange and concealed piano hinge.
2. Locations: **[Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>**.
3. Stainless-Steel Sheet for Door: **[Nominal 1.59 mm , 16 gage]**, No. 4 finish.
4. Frame Material: **[Same material, thickness, and finish as door]**.
5. Latch and Lock: Cam latch, key operated.

C. Flush Access Doors with Concealed Flanges <for Gypsum Board or Plaster>:

1. Description: Face of door flush with frame; with concealed flange for **[gypsum board] [plaster]** installation and concealed concealed hinge.
2. Locations: **[Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>**.
3. Uncoated Steel Sheet for Door: **[Nominal 1.52 mm , 16 gage], factory [primed] [finished]**.
4. Frame Material: **[Same material and thickness as door]**.
5. Latch and Lock: Cam latch, key operated.

D. Recessed Access Doors with Concealed Flanges < for Gypsum Board, Where Indicated>:

1. Description: Door face recessed **[13 mm] [16 mm] [25 mm] for [gypsum board] [plaster] [acoustical tile] <Insert material>** infill; with concealed flange for **[gypsum board] [plaster] [no bead for acoustical tile]** installation and concealed hinge.
2. Locations: **[Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>**.
3. Uncoated Steel Sheet for Door: **[Nominal 1.52 mm , 16 gage] <Insert thickness>**, factory **[primed] [finished]**.
4. Metallic-Coated Steel Sheet for Door: **[Nominal 1.63 mm , 16 gage] <Insert thickness>**, factory **[primed] [finished]**.
5. Stainless-Steel Sheet for Door: **[Nominal 1.59 mm , 16 gage] <Insert thickness>**, **[No. 4] [No. 2b]** finish.
6. Latch and Lock: Cam latch, key operated.

E. Lightweight Glass-Fiber-Reinforced Gypsum Access Panels

1. Description: Door and frame face flush with adjacent surfaces, lift-out panel with no hardware for ceilings and with touch-latch concealed hinges for wall installations.
2. Locations: Ceiling.
3. Corners: Radiused.

4. Embedments: As standard with glass-fiber-reinforced gypsum fabrication manufacturer and as required for reinforcement and for anchorage to substrates and framing.
5. Finish: Smooth for paint finish.

F. CAA Flush Access Doors and Frames:

1. Locations: Gypsum walls and concrete wall and ceiling surfaces.
2. Door: Minimum 4.5-mm- thick steel sheet, flush construction, minimum 300mm by 300mm leaf
3. Frame: Minimum 4.7-by-50-by-50-by-75-mm angle welded with joints ground smooth.
4. Hinges: Heavy-duty steel welded to door and frame.
5. Lock: Heavy-duty, detention deadbolt lock.
6. Hardware Material: Stainless steel, including latch and lifting mechanism assemblies, hold-open arms, and all brackets, hinges, pins, and fasteners.
7. Material: Glass fiber reinforced gypsum access door with radius corner at drywall board ceiling application.
8. Finish: Smooth for paint finish.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Exposed Flanges:

1. Description: Door face flush with frame, **[with a core of mineral-fiber insulation enclosed in sheet metal] [uninsulated]**; with exposed flange, self-closing door, and concealed hinge.
2. Locations: **[Wall] [Ceiling] [Wall and ceiling] <Insert location or substrate>**.
3. Fire-Resistance Rating: Not less than **[that indicated] [that of adjacent construction] [45 minutes] [1 hour] [1-1/2 hours] [2 hours] [3 hours] <Insert requirement>**.
4. Temperature-Rise Rating: **[250 deg C] [139 deg C]** at the end of 30 minutes.

5. Uncoated Steel Sheet for Door: **[Nominal 0.91 mm , 20 gage] <Insert thickness>**, factory **[primed] [finished]**.
6. Frame Material: **[Same material, thickness, and finish as door] <Insert material, thickness, and finish>**.

7. Latch and Lock: Self-latching door hardware, operated by key.

2.4 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum Z180 or ZF180 metallic coating.

D. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, **[Type 304] [Type 316]**. Remove tool and die marks and stretch lines, or blend into finish.

E. Glass-Fiber-Reinforced Gypsum: ASTM C 1355.

F. Frame Anchors: Same material as door face.

G. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.5 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

1. For recessed doors with plaster infill, provide self-furring expanded-metal lath attached to door panel.

E. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.

3. [Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in Section 087135 "Non-Security Door Hardware."]

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
2. Factory Finished: Apply manufacturer's standard powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 0.025 mm for topcoat.

a. Color: **[Match Project Director/COR's sample] [As selected by Project Director/COR from full range of industry colors]**.

E. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finish: No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

F. GFRG Finishes: Field primed and painted according to Division 09 section(s) on “Painting.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083115

SECTION 083322 - OVERHEAD FORCED-ENTRY (FE) COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. FE Service doors as scheduled in Construction Drawings. Refer to the Part 2 Article on PERFORMANCE REQUIREMENTS for FE rating and required level of corrosion resistance.

B. Related Requirements:

1. Section 055005 "Metal Fabrications" for corner guards and bollards.
2. Section 087155 “Security Door Hardware” for padlocks for overhead doors at loading dock for Service Entrance CAC.
3. Section 099602 “High-Performance FE/BR Coatings.”
4. Division 26 Sections for electrical wiring and conduit, fuses, disconnect switches, connection of operator to power supply, installation of control station and wiring, and connection to alarm systems.

1.2 ACTION SUBMITTALS

A. General:

1. Action submittals should be accepted by the Project Director/COR prior to procurement of associated items by the Contractor; premature procurement is at the risk of the Contractor.
2. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Product Data: For each type and size of overhead FE coiling door and accessory.

1. Include typical construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic-closing device and testing and resetting instructions.

C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include cover sheet with project identification, manufacturer name, address, and phone number.
2. Include plans, elevations, sections, and mounting details. Indicate applicable DOS door code.
3. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

4. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
5. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
6. Show locations of controls, locking devices, and other accessories.
7. Include diagrams for power, signal, and control wiring. Identify specific voltage requirements for project (i.e., 120 or 240 V).

D. Certificates: Provide one of the following, in accordance with the method of conformance selected by Contractor from two options identified in the Part 2 Article on CONFORMANCE TO SECURITY PERFORMANCE REQUIREMENTS:

1. Letter from manufacturer indicating the products have been certified by Bureau of Diplomatic Security (DS) in accordance with DS/PSP/PSD SD-STD-01.01, Revision H.

E. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

1.3 INFORMATIONAL SUBMITTALS

A. General:

1. Informational submittals shall be submitted at least two weeks prior to installation.
2. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Qualification Data: For Manufacturer and Installer.

1. Submit a resume for the installer lead showing that they meet the minimum requirements.

C. Installation Manual.

1.4 CLOSEOUT SUBMITTALS

A. General:

1. Refer to Division 01 Sections on Submittals and on Closeout for general administrative requirements.

B. Special warranty.

C. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

D. Certificate of Compliance for Installation.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: An entity with minimum of five years in design and fabrication of heavy overhead coiling doors for use in commercial applications, and in supporting installation and start-up for those doors.

B. Installer Technician Qualifications: An installer who has been trained in coiling door installation and maintenance of units required for this Project.

1. Lead installer shall have a minimum of 5-years of experience in installation of coiling doors and installed a minimum of 50 coiling doors.

C. Comply with the requirements of the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use and installation conditions.

D. Certification by General Contractor: Prior to final completion, the General Contractor shall provide to the Project Director/COR a certification that the FE materials have been installed in accordance with the manufacturer's instructions, these specifications and are operational. Use Certificates of Compliance forms at end of this Section. Deviation from these requirements is only permitted with the written approval of the Project Director/COR with input from the OBO/CFSM/SM Physical Security Engineer, Designer of Record, and OBO/OPS/FAC. Specifically the General Contractor's certification shall include verification that:

1. The Installer team leader trained the installation crew and supervised the installation of the FE coiling door.
2. All bolts/screws are per the approved shop drawings.
3. All access plates for each roll-up door have been installed as indicated in the approved shop drawings.
4. Each coiling door head has been installed level and the guide track curtain side jambs have been installed plumb and square.
5. Each lockset fully engages and freely operates.
6. Cycle test a minimum of 20 times:

   a. Limit Switches: Installed and operational.
   b. Emergency hand operated disconnect device for automatically engaging manual operator and releasing brake is installed and operational.
   c. Audible and Visual Signals: Audible alarm and visual indicator lights installed per the shop drawings.

7. Removable stops on guides have been installed.
8. Weatherseal has been installed.
9. When power is lost, while in the open position, the door remains open.
10. Manual override chain is functional.
11. Electric Operator:

12. Control Stations:

    a. Enclosure; for interior mounting.
    b. Push Buttons:

        1) Momentary-contact push-button controls are labeled "Open" and "Stop."
        2) Sustained- or constant-pressure push-button control is labeled "Close." For locations monitored by a guard booth (e.g., at Service CAC).
        3) Fourth momentary-contact push button at guard booth panel with ability to disable functionality of control panel adjacent to door is installed and functional.

    c. Monitoring Lights: At both control panels, include one light to confirm full closure, and second light to confirm constant pressure.

1.6 IDENTIFICATION SYSTEMS

A. Label: Identify each assembly to provide the Government with ready reference to original manufacturer to facilitate reorders, replacement parts, service, resolution of complaints, and inventory. The label shall be an embossed metal plate or metallic foil with adhesive backing for permanent identification. Locate label on door hood or motor housing. The label shall be approximately 40 x 125 mm (1-1/2 x 5 inches), and shall cite:

1. Manufacturer's name/city/state.
2. Contract number.
3. Month/year of manufacture.
4. Mark number.
5. Government certification model number if applicable and if provided by Diplomatic Security in certification letter.
6. DOS Code (e.g., 2141).
7. Serial Number if applicable.

B. ID Codes: Provide two stamped ID codes, with ID material matching door curtain. Locate one ID code adjacent to label, and one ID code on lowermost slat or locking bar of door.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver each assembly to project site with fabrication, finishing, and assembly of primary panels, and frames completed and prepared for installation and connection with security systems.

B. Pack door assemblies and accessories in crates. Provide two wood cross braces on both sides of the crates. Provide “Tip-and-tell” on inside of crate to assist in ensuring care was taken in shipment. Secure with screws placed on side of crate to be opened.

C. Provide protection of finish using self-adhesive paper.

D. Treat security door assemblies as fragile merchandise packaged and shipped in export wood crates with width end in upright position and blocked together in a mass. Comply with manufacturer's directions for storage and handling to prevent edge damage or other damage to assembly resulting from effects of moisture, condensation, temperature changes, direct exposure to sun, and contact with chemical solvents. Clearly mark crates to indicate which side shall be opened first.

E. In each crate, provide a separate compartment for installation hardware. Package and ship installation hardware (anchors, bolts, screws, shims, ballistic trim, shop drawings, etc.) for each door in the same crate as the door assembly.

F. Package and ship shop drawings and installation manual for each door in crate.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sensors: One set per unit type.
2. Controls: One set per unit type.
3. Switches: One set per unit type.

PART 2 - PRODUCTS

2.1 CONFORMANCE TO SECURITY PERFORMANCE REQUIREMENTS

A. Provide units, including frames and accessories, with the following certification:

1. Pre-Certified Units: Have been certified by Bureau of Diplomatic Security (DS) in accordance with DS/PSP/PSD SD-STD-01.01, Rev G or Rev H for identified level minutes of forced-entry protection.

2. Design for Locking Device: Door assembly shall be capable of being secured by one of the following Government-Furnished Government-Installed locks from the interior [Lock device is intended to prevent unauthorized use and does not need to be part of the Forced Entry as long as it controls/limits door access use locally at the door] :

a. Padlock with minimum 10 mm (3/8 inch) shackle diameter, and shackle clearance of 45 mm or less.

b. Lock accepting Medeco keyed six-pin LFIC interchangeable core.

2.2 PERFORMANCE REQUIREMENTS

A. Security: Fabricate and install these FE assemblies to achieve indicated levels of resistance. Extend resistance to include anchorages, interfaces with adjoining substrates, and hardware. Provide specific performance ratings, also referred to as Government Code numbers, as indicated below.

1. Forced-Entry (FE) resistant assemblies: Where overhead coiling door assembly is shown or scheduled as FE, provide door manufacturer's material and fabrication for panels, inserts, hardware, devices, and framing of units for **[5] [15]** minutes of forced-entry protection.
2. DOS Door Labeling: Table 2.2 “Door Codes” below identifies the generic system used by OBO for composite labeling of key performances and attributes for a variety of types of assemblies which incorporate FE and BR resistance. For Overhead FE Coiling Doors, these codes will apply as follows:

   a. 1st Digit: Code 2 will always be used.
   b. 2nd Digit: If applicable, code shall match fire-rating of specific assembly.
   c. 3 Digit: Code shall match FE rating of assembly.
   d. 4th Digit: If applicable, code shall match BR rating of assembly.

TABLE 2.2 – DOOR CODES

DOS CODE	1st DIGIT - DOOR COMPOSITION	2nd DIGIT - FIRE RATING	3rd DIGIT - FORCED-ENTRY RATING	4th DIGIT - BALLISTIC-RESISTANCE RATING
1	Transparent (various sized lites)	None	None	None
2	Opaque	1.5 hours (Class B, Class D at exterior)	15 minutes	NOT USED
3		3 hours (Class A)	60 minutes	Rifle 5.56 & 7.62 NATO
4		45 minutes (Class C)	5 minutes	Armor-Piercing (.30-06)
5		20 minutes	NOT USED	NOT USED
6		1 hour	NOT USED	NOT USED

B. Structural Performance, Exterior Doors: Capable of withstanding design wind loads as calculated in accordance with ASCE/SEI-7 standard (as referenced in the OBO Building Code, OBO-ICS IBC Chapter 16), or as identified in project-specific requirements:

1. Basic Wind Speed: **[As indicated on Drawings] <Insert loads>**.
2. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
3. Doors are not required to be operable under design wind load.

C. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to Chapter 16 of the OBO Building Code, including applicable references to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

D. Operation Cycles: Door components and operators capable of operating for not less than 20,000 total, and 20 per day. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

2.3 CORROSION RESISTANCE PERFORMANCE

A. Corrosion Resistance Standards: Provide materials and finishes for the components in accordance with this Article. for the project-specific corrosion risk identified above or elsewhere in the Contract Documents.

1. Corrosion Risk: As indicated in project Contract (e.g., Statement of Work). The OBO Building Code Appendix W categories, the OBO Atmospheric Corrosivity Level for this site is **[Low] [Moderate] [Extreme]**.
2. Corrosion Resistance Standards: Provide materials and finishes for the components in accordance with this article for the project-specific corrosion risk identified above or elsewhere in the Contract Documents.
3. Material Standards for Components: As Permissible Atmospheric Corrosivity Level (ACL) of site listed with each material below:

   a. Steel, Zinc-Coated (Galvanized): Steel sheet; complying with ASTM A653M low and moderate risk.
   b. Stainless Steel, Type 304: ASTM A666M; low and moderate risk
   c. Stainless Steel, Type 316: ASTM A240M; extreme risk.
   d. Aluminum: ASTM B209 (ASTM B209M) sheet or ASTM B221 (ASTM B221M) extrusions; low, moderate, and extreme risk.

4. Finish Standards for Components: As applicable for Risk Level of project site:

   a. Low and Moderate ACL Risk:

      1) Steel, Zinc-Coated (Galvanized): Steel sheet; complying with ASTM A653M. See Section 0996xx "High-Performance FE/BR.Coatings"
      2) Stainless Steel: Type 304: ASTM A666M **[ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 4 (polished directional satin)]**.
      3) Aluminum: Clear Anodic Finish: AAMA 611, **[AA-M12C22A41, Class I, 0.018 mm]** or **[Color Anodic Finish: [AA-M12C22A42/A44, Class I, 0.018 mm] or thicker.]**

   b. c. Extreme Risk:

      1) Stainless Steel: Type 316: ASTM A240M **[ASTM A480/A480M No. 2B (bright, cold rolled)] [ASTM A480/A480M No. 4 (polished directional satin)]**.
      2) Aluminum:

         a) Fluoropolymer coating conforming with FGIA/AAMA 2605 and having minimum 70 percent PVDF resin; provide pretreatment, primer, and other protection associated with severe environments. See Section 099602 "High-Performance FE/BR Coatings."

5. Hood Finish: Match curtain material and finish.
6. Curtain Jamb Guides:

a. Low and Moderate ACL Risk: Galvanized, aluminum, or stainless steel conforming to same standards as for general components above with same ACL risk.
b. Extreme ACL Risk: Stainless steel only, conforming to same standard as for general components above with same ACL risk.

7. Motor and control:

a. Low Risk Exposure: NEMA 4.
b. Medium or Extreme Risk Exposure: NEMA 4X.

2.4 DOOR CURTAIN CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices.

1. Door Curtain Slats: Flat profile slats of minimum 100 mm (4 inch) center-to-center height.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, continuous bar for windlocks, and retention groove integrated into body of slat use to retain slats within guides.

C. Endlocks/Windlocks: Retention groove integrated into body of slat use to retain slats within guides.

2.5 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Mounting: Inside face of wall and as indicated on Drawings.
2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.
3. Removable Metal Soffit: Formed or extruded from same metal and with same finish as curtain if hood is mounted above ceiling unless otherwise indicated.

2.6 CURTAIN ACCESSORIES

A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

1. At door head, use 1/8-inch- (3-mm-) thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, **[flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene] [nylon brushes] <Insert material>**.

2.7 LOCKING DEVICES

A. See the Part 2 Article on CONFORMANCE TO SECURITY PERFORMANCE REQUIREMENTS; required type of device relates to approach to certification utilized.

2.8 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless or welded carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 2.5 mm/m (0.03 in./ft) of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of cold-rolled steel plate, as required.

2.9 ELECTRIC DOOR OPERATORS

A. General:

1. Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
2. Electric operator and components capable of operating for not less than 20 cycles per day for each door.
3. Automatic Closure Speed: Maintain speed between 150 to 225 mm per second (6 to 9 inches per second).
4. Door Operator Location: Operator location as indicated for each door.

a. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
b. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
c. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
d. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
e. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.

5. Motors: Reversible-type motor[**with controller (disconnect switch)**] for motor exposure indicated for each door assembly.

a. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at automatic speeds identified above, without exceeding nameplate ratings or service factor.
b. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
c. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

6. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
7. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
8. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed [**110 N (25 lbf)**] [**130 N (30 lbf)**] <**Insert value**>.
9. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
10. Prevention of Gravity Closure due to Power Failure: When loss of power occurs, provide a fail-safe motor brake that engages keeping the door at status quo. The assembly shall be capable of manual operation during the loss of power
11. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.
12. Full Closure Sensor: Provide sensor adjacent to door to monitor full closure of door.

13. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
14. Control Stations:

    a. Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure; for interior mounting.
    b. Push Buttons: Include momentary-contact push-button controls labeled "Open" and "Stop," and sustained- or constant-pressure push-button control labeled "Close." For locations monitored by a guard booth (e.g., at Service CAC), include fourth momentary-contact push button at guard booth panel with ability to disable functionality of control panel adjacent to door.
    c. Monitoring Lights: At both control panels, include one light to confirm full closure, and second light to confirm constant pressure.

15. Notify electrical contractor to mount control station(s) and to supply appropriate disconnect switch, conduit, and wiring as identified in wiring instructions in overhead door manufacturer’s installation manual.
16. Door and operator meets UL325 for commercial operator requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at mounting locations indicated for each door.

    1. Refer to Construction Drawings and to Division 26 and 33 Sections for installation and infrastructure for Control Station mounted at the nearest CAC guardbooth location.
    2. Place one control panel adjacent to Overhead Coiling Door. When coiling door is in the perimeter of the compound, such as a CAC, place second control panel remotely, and locate in guardbooth unless identified otherwise; refer to the Part 2 Article on ELECTRIC DOOR OPERATORS.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish three copies of reports to Project Director/COR; they will forward copy to post Facility Manager and to OBO/CFSM/SM.

B. Perform the following tests and inspections**[with the assistance of a factory-authorized service representative]**:

1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 STARTUP SERVICE

A. Engage a coiling door technician to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

1. Adjust exterior doors and components to be weather resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

3.6 CLEANING

A. Clean surfaces soiled by work utilizing cleaning procedures and materials recommended by Manufacturer.

3.7 DEMONSTRATION

A. Engage a coiling door technician to train Government's maintenance personnel to adjust, operate, and maintain overhead coiling doors. Provide minimum of two 4-hour training sessions, with each held at a distinctly different time period to accommodate personnel identified by Project Director/COR. Review data in maintenance manuals.

1. Classroom duration: 2 hours
2. Field Demonstration: 6 hours

END OF SECTION 083322

Certificate of Compliance

Overhead FE Coiling Doors
FE Coiling Door Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the FE/BR products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

DESCRIPTION – TRAINING/ SUPERVISION

1	The Installer team leader trained the installation crew and supervised the installation of the FE coiling door.	**Installer Team Leader's Name/ Date:**

	DESCRIPTION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	All bolts/screws are per the approved shop drawings.		
3	All access plates for each roll-up door have been installed as indicated in the approved shop drawings.		
4	Each coiling door head has been installed level and the guide track curtain side jambs have been installed plumb and square.		
5	Each lockset fully engages and freely operates.		
6	Cycle test a minimum of 20 times.		
6a	Limit Switches: Installed and operational.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
6b	Emergency hand operated disconnect device for automatically engaging manual operator and releasing brake is installed and operational.		
6c	Audible and Visual Signals: Audible alarm and visual indicator lights installed per the shop drawings.		
7	Removable stops on guides have been installed		
8	Weather seal has been installed.		
9	When power is lost, while in the open position, the door remains open.		
10	Manual override chain is functional.		
11	Electric Operator: Provided		
12	Control Stations: Provided		
12a	Enclosure; for interior mounting.		
12b	Push Buttons provided: 1) Momentary-contact push-button controls are labeled "Open" and "Stop." 2) Sustained- or constant-pressure push-button control is labeled "Close." For locations monitored by a guard booth (e.g., at Service CAC). 3) Fourth momentary-contact push button at guard booth panel with ability to disable functionality of control panel adjacent to door is installed and functional.		
12c	Monitoring Lights: At both control panels, include one light to confirm full closure, and second light to confirm constant pressure.		

Installer Team Lead:	**Contractor's QC Manager:**
Printed Name: _____	Printed Name: _____
Signature: _____	Signature: _____
Initials: _____	Initials: _____

Noted Variances:

_____

_____

_____

_____

_____

_____

_____

DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

_____

_____

_____

_____

_____

[1] [2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

SECTION 083454 - FORCED ENTRY (FE) / BALLISTIC RESISTANT (BR) DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of forced-entry resistant (FE) and ballistic resistant (BR) door assemblies required for the Project is indicated on Contract Drawings, and in Door/Frame/Hardware schedules, including construction, profiles, swing, sizes, hardware, accessories, devices, and locations.

1. Install FE/BR door assemblies only into steel substrate in such a manner that allows for future frame adjustment. This may be structural steel wall or other structural steel assembly, steel sub-frame in concrete, or steel sub-frame attached to concrete or masonry.

B. Related Sections include the following:

1. Section 055005 “Metal Fabrications” for steel supports, except as noted within this Section.
2. Division 08 Sections for doors not designated for special security performances.
3. Section 087155 "Security Door Hardware" for hardware to be installed as work of this Section.
4. Division 08 Section for general glazing.
5. Section 088855 "Security Glazing."
6. Other sections of these specifications for interface of door hardware and device units, with alarm/security/safety/access/monitoring systems; not work of this Section.
7. Section 099602 “High-Performance FE/BR Coatings”

8. [Division 08 Section “GPE Window and Door Requirements.”]

C. [Definitions and Roles for Projects Utilizing the GPE Program:

1. Government Procured Equipment (GPE) Program: Program of the Overseas Buildings Operations (OBO) in which OBO procures security doors and windows in advance of and for use of upcoming projects. All GPE windows and doors shall be designed and engineered prior to award of the project to the Contractor.
2. Fabricator: This entity is fabricator/manufacturer of GPE items.
3. Manufacturer: This entity is manufacturer/fabricator of GPE items.
4. Contractor: Contractor is responsible for design incorporation, delivery, and installation of GPE products. Contractor is also responsible for design and construction of overall facility, as well as installation of GPE items selected by Contractor in conformance with overall requirements of the project. Contractor is responsible for development of a GPE product list and submission of the list to the Government for approval, with Design Development drawings.]

1.2 PRE-INSTALLATION MEETINGS

A. Before beginning installation of FE/BR assemblies, Manufacturer's technical representative shall conduct pre-installation conference at the Project site with installation sub-contractor, electrical sub-contractor, the Project Director/COR, and other interested parties to review installation procedures and manuals, schedules, and coordination of FE/BR-assembly installation with other elements of the Work.

1.3 ACTION SUBMITTALS

A. General:

1. Action submittals should be accepted by the PD/COR prior to procurement of associated items by Contractor; premature procurement is at the risk of Contractor.
2. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Product Data:

1. Product data for each element of work, whether purchased from other manufacturers or provided as door Fabricator's standard production to include door hardware, weather-stripping/gasketing and thresholds. Include data substantiating that products comply with requirements of these specifications.

C. Certificates:

1. Letter from manufacturer indicating the products have been certified by Bureau of Diplomatic Security (DS).
2. Letter from manufacturer indicating the swing weight of the door, as defined within this article, and the total weight of the door for standard rough opening door, 1086 mm x 2210 mm (nominal 3 foot x7 foot).
3. For doors equipped with multi-point locks.

   a. Letter from DOS, DS Lock shop, showing approval of multi-point lock for specific certified product.
   b. For doors equipped with delay egress device, provide letter from DOS, DS Lock shop, that the provided delay device is compatible with multi-point lock and DOS technical system and that annunciation is incorporated per the DOS multi-point lock requirements.

D. Shop Drawings:

1. General:

   a. Show each dimensioned detail of each door assembly.
   b. Indicate performance rating, swing, hardware set, and adjacent construction. Shop drawings must also clearly indicate all modified hardware sets.
   c. Provide drawings on B-size (297 mm x 420 mm) sheets. All dimensions shall be indicated in metric. Show typical door exterior elevations at not less than 1:20 scale.

d. Submittals in PDF format: Provide Table of contents and bookmarks organizing by building and floor for each product using contract identification number.
e. After final modifications and corrections have been incorporated into the drawings, submit drawings as AutoCAD files with .DWG extension in accordance with Division 01 project closeout requirements.

2. Cover sheet: Include manufacturer's name, address, telephone, and facsimile numbers; customer and address; project location; contract or purchase order number; and submittal release record.
3. General Notes and Details Sheets:

a. Manufacturer's name and reference numbers for primer and finish paint, including number of coats applied.
b. Information about insulation in door, when provided, and including weather-stripping.
c. Minimum size of FE/BR door shall conform to smallest clear opening requirement of 813 mm (32 inches) in OBO Building Code for accessibility, and for fire and life safety.
d. Terminal strip size, location, and height above bottom of door frame.
e. Door frame socket head cap screw horizontal slotted holes location and sizes.
f. Identify exact location on door and frame of two required ID plates; see the Part 1 Article on IDENTIFICATION SYSTEMS. Identify plate type and size, and type of information included on the plate about door.
g. All FE/BR door mounting bolts, screws and anchors shall be metric products.
h. Door frame socket head cap screws dry torque values
i. Hot-Dip Galvanization specifications refences for each material hot dipped.
j. Ballistic Trim (BT) Bar installation instructions and detail drawings
k. Glazing Panel Chart, including type, dimensions and weight.
l. Abbreviations used.
m. Provide list of any special fastening tools; see the paragraph on "Removable Covers" in the Part 2 Article on CLADDING in regards to tools required for release of snap-in-place covers.
n. Location of conduit entry into both sub-frame and door frame, separate sheet with partial door elevation drawings showing conduit entry and details
o. Sections/details showing FEL thumbturn guards and exterior FEL key guards, separate sheet with detail drawings (elevation, side and opening) and specifications.

4. Unit information:

a. Manufacturers model number.
b. DOS Code number.
c. Mark (door no.).
d. Door/frame finish.
e. Door type.
f. Government certification number.
g. Government certification number for glazing panel(s), if different from door certification.
h. Government certification number for deal tray, if different from door certification.

i. Blast characteristics (i.e., ASTM F2927-xx (xx denotes version at time of testing) and the resistance level achieved Level I, II, III/S, or none).

5. Elevation Drawings (Attack side):

a. Rough opening dimensions.
b. Door opening dimensions.
c. Frame opening dimensions.
d. Vision opening dimensions (in accordance with construction drawings).
e. Clear width opening dimension to demonstrate conformance to accessibility requirements in OBO Building Code Chapter 11.
f. Substrate/rough opening material.
g. Finished floor.
h. Weather-stripping. (hardware component keynote)
i. Door class (fire) rating: rated or non-rated.
j. Separate steel sub-frames (number and list).
k. Detail symbols.
l. Hardware and hardware symbols. Include part numbers, manufacturers and description.
m. Electrical access, including terminal strips.
n. FEL thumbturn guards and exterior FEL key guards, as required.
o. Location of conduit entry into both sub-frame and door frame.
p. Total weight of the actual (not the nominal door size or tested door size) door to include frame, door leaf, and all hardware.

6. Plan Drawings:

a. Relate to elevation on drawing.
b. Identify “Attack” and “Protected” sides.
c. Identify door swing (i.e., RH, LH, RHRB, LHRB).
d. Provide key notes on drawings.
e. Indicate room space numbers taken from Contract Drawings.
f. Clear width opening dimension to demonstrate conformance to accessibility requirements in OBO Building Code Chapter 11

7. Details: Show section at 1:5 scale of members indicating construction, size, and thickness of components. Details shall be on separate sheets from plan and elevations

a. Frame profile, anchorage
b. Steel sub-frames,
c. Continuous shim plates (where applicable),
d. Threshold configuration,
e. Glazing panel together with connections,
f. Section through the door that shows the vertical and horizontal rails, glazing, glazing stops, and cladding or any architectural treatments.
g. Fasteners,
h. Shim gap with dimensions and Shims,
i. Flashing, sealant, backer rods, gaskets,

j. Means of separating dissimilar metals.
k. Undercut for carpet.
l. Sill condition
m. Weather-stripping.
n. Door and frame thickness.
o. Ballistic trim and metric fasteners.
p. Detail shall include contract drawing information of "products by others" such as flashing and finishes surrounding the product and include dimensions of the products where they impact the design, rough opening sizes or installation of the FE/BR product.
q. Details for flashing and weather proofing shall be coordinated with the weather proofing submittal and design shall be shown for sill, head and jamb conditions.

8. Provide a drawing for each door hardware with TSS Wiring & Pneumatic (Terminal #, Terminal Wire, Device Wire, Function, Device Model & Device Type).
9. General Product Information: Include notes sheet, miscellaneous materials specifications, abbreviations, finish/paint system, legend, and glazing specifications.

a. Breakdown of Product Line Items:
b. If Manufacturer produces one contract line item as several parts (e.g., door with transom and sidelights), they shall break out items on drawings. Each item shall be a subdivision of that product line item number.

E. Engineering Calculations:

1. Submit project-specific engineering calculations as described herein and in the General Conditions and to address the performance requirements in this specification section for the door system and its attachment to the supporting building structure.
2. A Blast Report is required to validate items that were not part of the ASTM blast test, for example, concrete anchorages. The report shall have a summary narrative, a tabular summary of results, design sketches and supporting calculations. Calculations shall be numbered with a table of contents.
3. Submit engineering calculations concurrently with corresponding shop drawings.
4. Identify the location of door assembly within the building.
5. Calculations shall bear the seal of a Professional Engineer licensed in the appropriate jurisdiction.

F. Installation Instruction Manual:

1. Manual shall cite all anchorage components, including complete description of anchors, as well as installation criteria such as drilling specifications into concrete or masonry, torque requirements, minimum edge distance, spacing, etc. For sub-frame attachment to concrete, instructions shall include alert to installers to avoid cutting rebar during anchor installation.

a. Provide directions to accommodate/avoid reinforcing rebar.

2. Manual shall be customized for each type of application.

3. Manual shall include installation steps of contract drawing information of "products by others" such as flashing and finishes surrounding the product that identify the other work, where it interfaces with the product. Detailed installation for the "products by others is not required."
4. Develop instructions for unique conditions as they are identified.
5. Manual shall include step-by-step instructions for installing FE/BR doors with supporting photos, illustrations and figures that also includes sections for General Requirements, Safety, General Recommendations/Best Practices for Personal Protection, Equipment (PPE), List of Tools & Expendable Supplies, Door Removal from Crate, and Cleaning
6. Manual shall include step-by-step instructions for replacing the glazing panel with supporting photos, illustrations and figures that also includes sections for General Requirements, List of Tools & Expendable Supplies, Door Removal from Crate, and Cleaning. Identify any special requirement for using a Vacuum Lifter that is attached to an approved lifting equipment.

G. Manufacturer's Technical Representative shall submit list of unique project specific site conditions that require special manufacturer representative inspection and/or installation training.

H. [Samples for Verification:

1. [Door and Frame Corner Fabrication: Provide one 450-by-450-mm (18-by-18-inch) sample for record to OBO. Sample will include a minimum of: one hinge, full-size door corner including full-size sections of extrusions with factory-applied color finish, cladding and removable covers, weather-stripping, hinge, still, and glazing panel and glazing stops (if applicable). If directed by OBO, when a current sample is available at OBO headquarters, an additional sample is not required.]

1.4 INFORMATIONAL SUBMITTALS

A. General:

1. Informational submittals shall be submitted at least four weeks prior to installation.
2. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Qualification Data: For Manufacturer and Installer in accordance with the Part 1 Article on QUALITY ASSURANCE.

C. Mill Certificates: Signed by metal manufacturers, certifying that products furnished comply with requirements of this Section, including requirements associated with chemical and physical properties.

D. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.5 CLOSEOUT SUBMITTALS:

A. General:

1. Refer to Division 01 Sections on Submittals and on Closeout for general administrative requirements.

B. Special Warranty: Provide special warranty in accordance with the Part 1 Article on WARRANTY.

C. Maintenance Data.

1. Data shall include instructions for cleaning and maintenance of Spall Shield glazing layer.

D. Inspection Reports and Certificate of Compliance: See forms at end of this Section.

1. Provide Table of contents and/or bookmarks organizing by building and floor for each product using contract identification number.
2. Provide plan showing location of products (one plan may cover multiple products or whole floor if legible).
3. Provide completed certificates of compliance documenting that all FE/BR door assemblies have been installed in accordance with contract documents. Signed by certified installer.
4. Provide any additional QC documents used by Contractor during the installation.
5. Mill Certificates: Signed by metal manufacturers, certifying that products furnished comply with requirements, including chemical and physical properties.
6. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Quality Control for Forced-Entry/Ballistic Resistant (FE/BR) Products: Certify compliance of fabricated and assembled FE/BR products specified in this Section with each quality control procedure established by the Government; these procedures are identified in Compliance Form at end of this Section. Other quality control forms are also found at end of this Section.

B. Testing Laboratory Qualifications: For compliance with non-security performance requirements on security door assemblies of this Section, use only those testing laboratories, which have successfully demonstrated to Project Director/COR that they have experience and capabilities needed to satisfactorily conduct required tests.

C. Delegated Design Responsibility: Contractor shall retain an experienced Professional Engineer, registered in the U.S. or in country with significant experience with doors of similar complex performance requirements, and acceptable to the Project Director/COR, to perform responsibilities of Delegated Design.

D. Installer Qualification Data: Submit resumes of all team lead installers (present and responsible for each install) documenting that installer has installed FE/BR door assemblies for a DOS project within last five years. Resume shall include at least three references (including contract information) that can provide verification that installer has expertise required to perform successful installation. Installer's qualifications requires approval by the Office of Overseas Buildings Operations, Construction Facilities Security Management, Security Management, Security Countermeasures Division, Security Engineering Branch (OBO/CFSM/SM/SCD/SEB) and/or FE/BR Program, and the Project Director/COR. Each installer of the installation team shall

be certified by manufacturer as being capable of properly installing the FE/BR doors as part of the on-site Manufacturer's Technical Representative training. The Contractor shall provide written documentation to the Project Director/COR that the installation team is certified in their products installation. Certification to be on the FE/BR manufactures letter head and indicate dates of training and what products they are certified to install.

E. Manufacturer's Technical Representative: For non-GPE project, the manufacturer shall provide technical representative to the project; for GPE projects Contractor shall hire from manufacturer technical representative. Manufacturer's technical representative shall be an employee of manufacturer, and have the following responsibilities:

1. Pre-Installation Conference: See Part 1 Article on PRE-INSTALLATION MEETINGS.
2. Installation Team Training: Manufacturer's technical representative (at no cost to the U.S. Government) shall provide the crew which is to actually perform installations of FE/BR assemblies with minimum of 16 hours of on-site, hands-on training, to include installation of three FE/BR doors.
3. Inspection: See Part 3 Article on FIELD QUALITY CONTROL.
4. Additional Assistance: Manufacturer's technical representative (at no cost to the U.S. Government) shall provide General Contractor any additional advice, instruction, training, supervision, or inspection required to enable General Contractor to complete installation certification described below.

    a. Provide training to the General Contractor to allow them to train the Embassy staff in proper operation and maintenance of FE/BR assemblies.

F. Certification by General Contractor: Prior to final completion, General Contractor shall provide to the Project Director/COR a Certificate of Compliance for each FE/BR door, verifying that each door has been installed in accordance with manufacturer's instructions and the requirements of these Specifications, and is operational. A sample Certificate of Compliance is attached at the end of this Section. Deviation from these requirements is only permitted with the written approval of OBO/CFSM/SM/SCD/SEB or OBO/CFCM/SM/SOD/PSO/FE/BR. Specifically, General Contractor's certification shall include verification that:

1. Manufacturer's technical representative was on site during initial stages of installation and for site-specific unique conditions as required. Team installing door assemblies has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.
2. Verify no damage has occurred to crate during shipping, no 'tip-and-tell' devices are tripped, and BOM (Bill of Materials) is accurate.
3. Each sub-frame has been installed level, plumb and square.
4. All sub-frame assemblies were factory welded, and any large sections that exceed limits of standard shipping containers were clearly identified for field welds.
5. All units with glazing panels were pre-glazed at the factory.
6. Employees performing installation meet specified training and experience qualifications.
7. Employees performing installation meet specified training and experience qualifications.
8. Each door frame head was installed level, and side jamb installed plumb and square.
9. All frame socket head cap screws and threaded openings in sub-frame were cleaned of all oil and debris, were dry-torqued to meet manufacturer's specifications, and were centered

in slotted door frame holes so that slotted hole is visible on both sides of washer. Shims were inserted at all socket head cap screw locations.

10. Frame screws are manufacturer supplied in accordance with approved shop drawings. Deviations from this shall be submitted through Project Director/COR to OBO/CFSM/SM FE/BR Coordination Board for their technical review and approval during shop drawing review phase.

    a. **[Existing Door Replacement: Whenever possible, same screw size and pattern may be used. When existing FE/BR door is being replaced, existing screw may be 12mm diameter screw, and washer grade 8 or equivalent class 10.9 or 12.9 historically used in past. In coordination with OBO/SM, replacement door may use this same attachment.]**

11. All door frame shims are plastic or stainless steel, horseshoe shaped, and 1.5 mm (1/16”) thick with break-away tabs.
12. Shim: All door socket head cap screws were installed and fully shimmed, minimum one shim per screw. Shim gap may exclude through wall flashing and weather proofing up to an additional 3-mm beyond the 6.5 mm, or the as tested gap limits referenced in this section (i.e., gap at the head could be 6.5 mm, plus 3 mm for a drip edge and through wall flashing for a total gap of 9.5 mm, or as tested, at the head or if the weather proofing was thinner, the total allowable gap would need to reflect the weather proofing plus 6.5 mm, or as tested gap space)
13. In no case shall the combined tested gap and weather proofing exceed 12-mm between subframe and the door frame.
14. Doors may be mounted maximum of 6.5 mm proud of subframe on attack side.
15. Door frame socket head cap screw horizontal slotted holes are 19 mm x 35 mm (3/4 inch x 1-1/4 inch) radiused access holes. Washers shall be 27 mm diameter.

    a. **[Existing Door Replacement: Slotted holes may match existing.]**

16. At each door assembly, there is continuous, plus or minus 1.5 mm (1/16 inch), gap between door leaf and door frames, as indicated in FE/BR manufacturer’s shop drawings.
17. Door does not bind on surrounding floor area and provides minimum of 6 mm of clearance between door leaf bottom and floor at any point in door swing after final floor finish has been applied.
18. Aluminum threshold cover plates were installed, and do not exceed limits for accessibility in accordance with OBO Building Code Chapter 11, and as indicated in approved shop drawings.
19. Weather proofing and flashing is installed through the frame and terminated as shown on the approved shop drawings.
20. Door Under cuts:

    a. If there is a threshold, the undercut between the bottom of the door and the top of the threshold shall not exceed 6 mm. Distance between the bottom of the door and the floor slab should not exceed 19mm including threshold.
    b. If there is no threshold, the undercut between the bottom of the door and the top of finish floor shall not exceed 6 mm and shall not exceed 12 mm for carpet (top of finish slab to bottom of the door).

21. Ballistic trim bars have been screwed to sub-frame and not door frame, and as shown on approved shop drawings. Maximum gaps at shim space shall not exceed as tested.

    a. Ballistic trim shall be designed to take into account dimensional requirements of flashing or weather proofing.
    b. Ballistic trim shall be tight to the subframe.
    c. Ballistic trim shall be tight to the door frame and a construction tolerances of up to a maximum of 3 mm is acceptable between the frame and ballistic bar.

22. The door is to be installed plumb and in accordance with approved tested assembly and shop drawings.
23. All forced entry lock (FEL) strikes engage their strike plates with no binding
24. No part of FE/BR door has been altered. No part of FEL has been altered, including but not limited to grinding, bending, cutting or re-welding any part of FEL strike, strike plate (steel coupon with vertical slot welded or screwed to frame) and (if applicable) strike plate receiver (vertical slot in door leaf). The only acceptable fix for defective or altered parts is to unbolt altered piece and replace altered piece in its entirety.
25. No finish materials including exterior cladding or interior trim overlaps door frame/sub-frame gap and ballistic trim bars unless finish materials can be easily removed and reinstalled. Any overlapping finish work (i.e., metal, wood, stone, gypsum board, etc.) must be capable of removal without damaging door frame and surrounding finish work. Door and frame were installed such that removal of door and frame is possible without demolishing finishes and trim, allowing door frame to be adjusted in future, 6 mm in or out of opening.
26. Any cladding that covers door frame screw access holes has either access holes with cap plugs or is attached with screws for easy removal without damage for reinstallation. Cap plugs and cladding for each door have been bagged and will not be installed until after final QA inspection has been conducted by OBO/SEB or FE/BR representative.
27. Manufacturer and installer ensures any decorative cladding around electromagnetic locks installed on door frame will allow lock position to be adjusted in both directions.
28. All access plates for each door have been installed as indicated in approved shop drawings.
29. Each lockset, deadbolt and panic exit device is able to fully engage and freely operate.
30. On doors with panic hardware, panic exit device strike plate has been installed in location that will eliminate any door leaf bounce between door leaf and frame.
31. Each door closer has been installed and closing speeds, latching speeds, and back-check has been adjusted in accordance with manufacturer's instructions. Doors shall close and latch in 5-7 seconds.
32. Automatic door operators have been adjusted as appropriate in accordance with manufacturer's instructions to conform to accessibility and fire protection requirements of the OBO Building Code.
33. Manufacturer has provided two embossed/printed metal plate or metallic foil for each product using machine-applied letters and numbers with raised characters. Locate one label on door frame header so that it is not exposed when door is closed and is clearly visible and not obscured by hardware when door is open. Locate second label on top edge of door leaf.

1.7 IDENTIFICATION SYSTEMS

A. Identify each assembly to provide the Government with ready reference to original manufacturer to facilitate reorders, replacement parts, service, resolution of complaints, and inventory. Provide two identification labels per door assembly. Labels shall be embossed/printed metal plate or metallic foil with adhesive backing for permanent identification. Locate one label on door frame header so that it is not exposed when door is closed and is clearly visible and not obscured by hardware when door is open. Locate second label on top edge of door leaf. Labels shall be approximately 40 x 75 mm and shall cite:

1. Manufacturer's name/city/state.
2. Contract number.
3. Month/year of manufacture.
4. Mark number.
5. Government certification model number.
6. DOS Code (i.e., 1123, 2123, etc.).
7. SHW Hardware package number/Modification number (as applicable).
8. Blast characteristics (i.e., ASTM F2927-xx (xx is the version at time of testing) level I, II, III/S or none).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver each assembly to project site with fabrication, finishing, and assembly of primary panels, completed and prepared for installation and connection with security systems. Disassemble hardware for shipping only to extent hardware interferes with shipping. Refer to Division 01 Section “Secure Shipment” for additional requirements.

B. Deliver door assemblies with glazing panels as factory glazed unless otherwise directed by the Government.

C. Pack door assemblies and accessories into maximum of two crates for door and ballistic trim, installation anchors and cladding. Package and ship installation hardware (anchors, bolts, screws, shims, ballistic trim, shop drawings, etc.) for each door in same crate as door assembly.

D. Provide at least two wood cross braces on both sides of crates. In each crate, provide a separate compartment for installation hardware. Provide “Tip-N-Tell” indicators on inside of crate to assist in ensuring care was taken in shipment. Secure side of crate to be opened with screws. Package and ship shop drawings and installation manual for doors prior to door assembly**[may be shipped with the doors]**. When shipped with doors, crate shall clearly indicate on the outside that it contains the shop drawings and installation instructions and be marked, “open first.”

E. Embeds and subframes may be shipped in a container or crated and shall be braced to minimize damage to the finish and studs (embeds).

F. Provide removable spreader bar between jambs used during fabrication, delivery, and installation and to include mullions of each frame assembly, except where threshold covers the spreader bar. Do not mar finishes of assembly with installation or removal of spreader bars. Removeable with mechanical fasteners so as to not damaging finishes and coatings.

G. Provide protection of pre-finished units, such as pre-finished glass or stainless steel, using self-adhesive paper or film or other protective material. In all cases protective material shall be suitable for shipping, storage and construction environments.

H. Treat security door assemblies as fragile merchandise packaged and shipped in export wood crates, with width end in upright position and blocked together in a mass. Comply with manufacturer's directions for storage and handling to prevent edge damage or other damage to assembly resulting from effects of moisture, condensation, temperature changes, direct exposure to sun, and contact with chemical solvents. Provide at least two wood cross-braces for door assembly. Clearly mark crates to indicate which side shall be opened first.

I. Clearly mark sub-frames with door mark number and identify head and left and right jambs.

J. Each door shall be shipped with fly sheet that includes all of the identification information found in the Part 1 Article, on IDENTIFICATIONS SYSTEMS.

K. Contractor shall ship sub-frames with adequate temporary bracing for shipping to ensure original shape and configuration.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Failures including excessive glazing deflection, water leakage or air infiltration.
c. Deterioration of metals, other materials, and metal finishes beyond normal weathering.
d. Failure of insulating glass. condensation in air gap in insulated glass.
e. Failure of hardware components.
f. Delamination of glazing layup.

2. Warranty Period:

a. Doors: Manufacturer will warrant the doors for a period of five years from substantial completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Fabricate and install FE/BR door assemblies to achieve indicated levels of FE/BR resistance. Extend resistance to include anchorages, interfaces with adjoining substrates, and hardware. Provide specific performance ratings, also referred to as Government Code numbers,

as indicated below. Refer to Article on MATERIALS, GENERAL for composition portion of Government Code.

B. Certified Units: Provide units, including frames and sub-frames which meet the following requirements:

1. Have been certified by Department of State, DS/PSP/PSD SD-STD-01.01, Revision H, Certification Standard, Forced Entry and Ballistic Resistant Standards, dated 16 June 2020.
2. Where required on the exterior of blast designed buildings, provide door that has been tested and passed the latest ASTM F2927-xx, along with the DOS DS ASTM F2927 supplement to damage level I, II, or III/S. Hardware shall comply with Specification Section "087155 Secure Door Hardware".

C. DOS Door Codes: See Table 2.1 "Door Codes" below:

TABLE 2.1 – DOOR CODES

DOS CODE	1st DIGIT - TRANS-PARENCY	2nd DIGIT - FIRE RATING	3rd DIGIT - FORCED-ENTRY RATING	4th DIGIT - BALLISTIC-RESISTANCE RATING
1	Transparent	None	None	None
2	Opaque	1.5 hours (class D at exterior)	15 minutes	Note Used
3	*	3 hours (class A)	60 minutes	Rifle 5.56 & 7.62 NATO
4	*	45 minutes (class C)	5 minutes	Armor-Piercing (.30-06)

Notes for above Table 2.1:

1. Composition - Column 1: Designated whether door has a transparency.
2. Fire Rating - Column 2: Fire-rated assemblies: Where indicated for fire resistance, provide flush steel doors-and-frame units; comply with NFPA 80, Standard for Fire Doors and Windows. Provide units that have been tested by recognized testing agency in accordance with NFPA No. 252 and ASTM E 152. Provide rated units where shown or scheduled.
3. Forced Entry Rating - Column 3: Forced-Entry (FE) resistant assemblies: Where door assembly is shown or scheduled as FE, provide door manufacturer's material and fabrication for panels, inserts, hardware, devices, and framing of units for the ratings as noted above.
4. Ballistic Resistance Rating - Column 4: Ballistic resistant (BR) assemblies: Where door assembly is shown or scheduled as BR, provide door manufacturer's materials and fabrication for panel, inserts, and framing of units for the ratings as noted above.

D. Structural Performance: Force entry / ballistic resistant door assemblies shall withstand the effects of wind loads determined, with no permanent deformation or breakage within door assembly when designed in according to ASCE 7-16, as adopted and amended by the OBO Building Code.

1. Basic Wind Speed: Shall be as indicated in the Structural Drawings.

E. Blast Resistance:

1. [TEXT PREPARED BY A QUALIFIED AND CLEARED BLAST CONSULTANT, WITH PROJECT-SPECIFIC PERFORMANCE REQUIREMENTS OR DESIGN, SHALL EITHER BE INSERTED IN THIS LOCATION OR PROVIDED IN A SEPARATE DOCUMENT AND REFERENCED IN THIS LOCATION. PREFERENCE IS FOR INSERTION IN THIS LOCATION.]

2.2 MANUFACTURERS

A. Selection of fabricator/manufacturer for each type of security door assembly, and selection of manufactured elements, which are used in make-up of that assembly, are Contractor's options subject to the following requirements and limitations, and subject to general provisions of Construction Contract:

1. Pre-certified fabricators (by DS) of ballistic-resistant and forced-entry-resistant assemblies are identified in a separate Contract Attachment labeled "Government Certified FE/BR Products and Designs".

B. Standardized Door Unit Dimensions: In a new construction, FE/BR doors shall be sized in a standardized manner for cost-efficiency and future operation and maintenance.

1. Single door width shall be standard rough opening of 1086 mm (nominal minimum 3’-0” door leaf) and increases is rough opening width shall be based on 50 mm increments up to 1386 mm maximum rough opening width (4’-0” nominal door leaf width).

a. Manufacturer’s 1086 mm door shall provide a minimum clear opening of 815 mm (32 inch), as defined by life safety requirements for egress. Failure to meet the minimum egress clear width will automatically disqualify the product.

2. Double door width shall be standard rough opening of 2050 mm (two nominal minimum 3’-0” door leaves) and increases is rough opening width shall be based on 150 mm increments up to 2350 mm maximum rough opening width.

a. Manufacturer’s 2050-mm double door shall provide a minimum clear opening of 815 mm (32 inch), as defined by life safety requirements for egress, for the active leaf. Failure to meet the minimum egress clear width will automatically disqualify the product.

3. Single and Double door heights shall be a standard rough opening of 2210 mm (nominal 7’-0” door leaf height) and may be increased in 100 mm increments up to 2510 mm (8’-0” nominal door leaf height).

4. Use of non-standardized door unit size needs Project Director/COR approval.

2.3 MATERIALS, GENERAL REQUIREMENTS FOR FE/BR DOOR ASSEMBLIES

A. Corrosion Resistance Performance:

1. Atmospheric Corrosion Risk: As indicated in Project Contract (e.g., Statement of Work), the OBO Building Code Appendix W defined OBO Atmospheric Corrosivity Level for this site is **[Low] [Moderate] [Extreme]**. The atmospheric corrosion risk exposure risk type for a given component shall be as defined by OBO Building Code R101.1.2 (i.e., direct exterior, indirect exposure to exterior, and interior exposure only).
2. Corrosion Resistance Standards: Provide materials and finishes for the components in accordance with the material specifications of this Specification Section and the general material type as indicated by this article for project-specific corrosion risk identified above or elsewhere in Contract Documents.
3. Material Standards for Door Components (e.g., inserts, tie rods, hardware, anchors, clips and fasteners) - Exterior Doors: As applicable for the OBO Atmospheric Corrosivity Level (ACL) of site and for both direct exterior exposure and indirect exposure to the exterior:

   a. Mild Steel: Hot-dipped galvanized coating; low and moderate ACL.
   b. Stainless Steel: Low, moderate, and extreme ACL.
   c. Aluminum: Low, moderate, and extreme ACL.

4. Ballistic metal inserts (wholly contained within the door) for forced entry, ballistic and/or blast for aluminum doors and as applicable for the OBO Atmospheric Corrosivity Level (ACL) of site and for both direct exterior exposure and indirect exposure to the exterior:

   a. Stainless Steel: AISI Type 316/316L, 2101 or 2205; low risk, moderate risk, and extreme ACL.
   b. High Strength Steel: various types, when coated to prevent galvanic and other forms of corrosion and when cavity is provided with drain; low, moderate, and extreme ACL with pre-approval of OBO/CFSM/SM/SCD/SEB and OBO/PDCS/DE/CSE.
   c. Other metals or other materials: low, moderate, and extreme ACL with appropriate measures to minimize galvanic corrosion with dissimilar metals.

5. Wood Composite Doors: Not allowed on exterior door applications; low, moderate, and extreme ACL.
6. Interior doors: Material for doors located in interior exposure only conditions, as defined by OBO Building Code R101, shall conform to galvanized mild steel or aluminum, if not indicated otherwise on the Construction Drawings.
7. Finish Standards for Components: as applicable for project site: See finish requirements of this section and Section 099602, “High-Performance FE/BR Coatings.”

B. Assembled Door Characteristics:

1. Maximum weight for single leaf door (include only door slab, hinges, and locking/access devise (FELs and Corbin Russwin 2067 or Multi Point lock (MP)) for full vision or opaque door designed for a 1086 mm x 2210 mm rough opening:

a. Steel Doors:

1) Doors with FEL's and Corbin Russwin: 290 kg.
2) Doors with multi-point Lock: 312 kg.

b. Stainless Steel Doors:

1) Doors with FEL's and Corbin Russwin: 337 kg.
2) Doors with multi-point Lock: 359 kg.

c. Aluminum Doors:

1) Doors with FEL's and Corbin Russwin: 276 kg.
2) Doors with multi-point locks: 300 kg.

2. Maximum Thickness: 70-mm (2-3/4 inches), excluding door hardware, cladding and FEL protector. Glazing stop cannot protrude beyond either surface plane of the door, except as noted for aluminum doors. No fasteners used to secure the glazing stop shall be visible.
3. Maximum Stile Width and Top Rail Height: 203 mm (8 inches) in vision leaf.
4. Bottom Rail Height: 255 mm (10 inches) in vision leaf (measured from the finished floor to bottom of the glazing).
5. On exterior doors, provide door continuous weather-stripping installed in factory between door leaf and door frame.

C. Acoustic Door Core Insulation (Not Thermal):

1. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics in any voids.

D. Glazing Panels, General: Fabricate glazing panels of sizes shown and scheduled with same performance capabilities as specified/shown for door assembly where installed. Where applicable, achieve performances and combined performances through lamination of transparent sheets, films, and screens of standard manufactured/tested products. Comply with applicable provisions of Division 08 general glazing section and Section 088855 "Security Glazing."

1. Forced-Entry (FE) Resistance: Where assembly is indicated for forced-entry resistance rating (FE), provide glazing panel of size shown or scheduled in accordance with Bureau of Diplomatic Security (DS) certification.
2. Ballistic Resistance (BR): Where assembly is indicated for ballistic-resistance rating (BR), provide glazing panel of size shown or scheduled in accordance with DS certification.

E. Sealants: For sealants required within fabricated security doors, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, non-shrinking, and non-migrating.

2.4 MATERIALS, GENERAL REQUIREMENTS FOR MILD STEEL DOORS

A. Hot-Rolled Steel Sheets and Strips: ASTM A 569, commercial quality, pickled and oiled, except as otherwise indicated.

B. Cold-Rolled Steel Sheets: ASTM A 366, commercial quality, except as otherwise indicated.

C. Galvanized (Zinc-Coated) Steel Sheets: ASTM A 653, minimum G90 zinc coating, mill phosphatized; commercial steel, except as otherwise indicated. Zinc-iron alloy-coated (galvannealed) steel sheet products are not permitted.

1. Stainless Steel Sheets where required for finish: AISI Type 316/316L, complying with ASTM A240; commercial quality, No. 4 directional polish.
2. Plates, Bars, Angles, and Channels: ASTM A36 or ASTM A572
3. Hollow Structural Sections (steel tubes): ASTM A500 or ASTM A1085.
4. Supports and Anchors: For wall assemblies, hot-dip zinc coat support/anchor units after fabrication in compliance with ASTM A 153, Class B.
5. Inserts, Bolts Fasteners: Standard units of strengths required to endure performances; hot-dip zinc coated where used in exterior wall assemblies in compliance with ASTM F2329.
6. Hot-Dip Galvanizing: All mild steel door components must be hot-dip galvanized in accordance with ASTM A123/A123M.

2.5 MATERIALS, GENERAL REQUIREMENTS FOR STAINLESS STEEL DOORS

A. Stainless Steel Plates, Sheets, and Strips: AISI Type 316, 316L, 2101 or 2205, complying with ASTM A240/A240M or ASTM A895/A895M, commercial quality.

B. Stainless Steel Bars and Shapes: AISI Type 316, 316L, 2101 or 2205, or AISI Type 316L where welding is to be performed, complying with ASTM A276/A276M or A582/A582M.

C. Stainless Steel Tubing: AISI Type 316, 316L, 2101 or 2205, complying with ASTM A1016/A1016M.

D. Stainless Steel Wire and Rod: AISI Type 316, 316L, complying with ASTM A555/A555M.

E. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers: AISI Type 316 (Alloy Group 2), complying with ASTM F593 and ASTM A594, or ASTM A193 and ASTM A194, or ASTM A320 and ASTM A194; provide compatible AISI Type 316 washers where appropriate.

2.6 MATERIALS, GENERAL REQUIREMENTS FOR ALUMINUM DOORS

A. Maximum Thickness: 70-mm (2-3/4 inches), excluding door hardware, FEL protector and glazing stop, as noted in this Article. Surface-applied glazing stop shall be allowed, if necessary, only on protected side and bump-out thickness shall be less than 13 mm. No fastener shall be used on architectural glazing stop toward the protected side door face while a counter-sunk type fastener can be acceptable on perpendicular face of glazing stop to door protected side face.

1. Glazing stop frame(s) shall not exceed 40 mm in width 13 mm beyond the face of the door and shall be configured internally to cushion all perimeter edges and faces of glazing. Glazing stop frame shall not produce pinch point with hardware. All external bolts to attach glazing stop frame shall be flush mounted or concealed as noted in section 2.4 Alternatively, protruding bolt heads shall be covered with additional trim frame and flush mounted screws.

B. Minimum Aluminum Extrusions: In compliance with FE/BR performance of tested assembly.

C. Aluminum Sheets, Plates, Bars, Tubes, and shapes; Must be in compliance with Aluminum: ASTM B209 (ASTM B209M) stretcher-leveled aluminum alloy or ASTM B221 (ASTM B221M)

D. Minimum sheet thickness: Sheet one-piece 1.02 mm (0.040-inch).

E. Inserts, Bolts, Fasteners: Standard units of strengths required to endure performances; Stainless steel, grade shall match tested/certified condition. Provide compatible washer that minimizes galvanic action. See the Part 2 Article on DOOR COMPONENTS for frame to subframe attachment for anchor bolt requirements.

1. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers: AISI Type 316 (Alloy Group 2), complying with ASTM F593 and ASTM A594, or ASTM A193 and ASTM A194, or ASTM A320 and ASTM A194; provide compatible AISI Type 316 washers where appropriate.

F. Door Core Insulation: Not required but may be provided.

G. Glazing Panels, General: Fabricate glazing panels of sizes shown and scheduled with same performance capabilities as specified/shown for door assembly where installed. Where applicable, achieve performances and combined performances through lamination of transparent sheets, films, and screens of standard manufactured/tested products. Comply with applicable provisions of Section 088855, "Security Glazing."

2.7 MATERIALS, GENERAL REQUIREMENTS FOR COMPOSITE DOORS

A. Composite doors may be allowed with approval of OBO and DS and the vendor shall provide material properties and designs for evaluation before DS certification testing.

B. Weights of composite doors shall not exceed the requirements for steel doors.

2.8 HARDWARE

A. General: Provide special units of door hardware to achieve performances, and as shown and scheduled. Standard units for each security door assembly are specified to be furnished as work of Section 087155 "Security Door Hardware"; see Project "Finish Hardware Schedule" and "Data Sheets," and provisions of this Section, as well as notes on door-and-frame schedule.

B. FE and FE/BR Hinges:

1. For FE and FE/BR doors, provide ANSI/BHMA compliant extra-heavy duty needle bearing type hinges, minimum 910 kg (2000 pound) capacity per hinge, for door leaves weighing 200 kg (450 pounds) or more and minimum 450 kg (1000 pound) capacity per hinge for door leaves weighing 200 kg (450 pounds) or less. Polymer and Teflon bearing hinges are not permitted. Provide cycle tested hinges in accordance with ANSI/BHMA 156.1-2013 on an actual door specimen for largest and heaviest planned use to a minimum of 1,000,000 cycles. Test shall be performed using hinges installed in accordance with DS forced-entry test in number and in how hinges are attached. Other minimum requirements are as follows:

    a. Cycle Testing: 1,000,000 (exceeds ANSI requirements; DOS-specific requirement).
    b. Hinge Pin Rise: None Allowed.
    c. Hinge Play: 0.38 mm (.015 inch).
    d. Vertical Wear: 0.76 mm (.030 inch).
    e. Lateral Wear: 1.60 mm (.062 inch).

2. Continuous hinges are prohibited.
3. For doors exceeding maximum standard height, additional hinges may be required and OBO/CFSM/SM/SOD shall review and approve the number proposed hinges before any submission for certification.
4. Welded attachment between hinges and doors and between hinges and frames are prohibited.
5. Stamp each FE and FE/BR hinge with initials of hinge Manufacturer, initials of FEBR door manufacturer and month and year hinge was manufactured, visible on hinge prior to installation.

C. All forced entry locks (FEL) shall include an adjustable and removable strike plate that is bolted with countersunk fasteners (no Philips or regular screws allowed). Strike plates shall be adjustable (in and out) a minimum of 2 mm in each direction.

D. All forced entry locks (FEL) that include a thumbturn, or lever, or exterior keyed FEL's, below 900 mm shall have protective guard to prevent damage to thumbturn or cylinder. The protection shall meet the following requirements:

1. Protect thumbturn on minimum three sides.
2. Be removable and replaceable without disassembly of door.
3. Extends beyond edge of thumbturn, or face of FEL cylinder, a minimum of 1.5 mm.
4. Provides enough clearance (minimum 12-mm) between guard and thumburn, or lever, to allow ease of operation of thumbturn/lever or key.
5. Provide guards that are capable of withstand strike of a blunt object without cracking, bending or fastener failure.
6. Guards shall be designed to minimize risk of snagging clothes (i.e., dresses or pants) should they brush guard while passing through door.
7. Guard designs shall be minimalistic and in congruent with architecture design, including finishes.

E. Mortised Door Hardware, including multi-point locks, shall be installed so that it can be adjusted, repaired, replaced or access to wiring without removal of entire door leaf surface steel or aluminum sheets. No service access to hardware from exterior side of door is allowed.

1. Cover plates shall be designed to blend with architecture of door, and screws shall be counter sunk and finishes of plates and fasteners shall match finish of door to the extent feasible.

F. Doors equipped with multi-point locks and delayed egress shall incorporate annunciations per the DOS multi-point lock requirements.

G. Weather Stripping and Seals: Provide continuous weather stripping/gasketing on all exterior doors and smoke, light or sound gasketing on interior doors where indicated or scheduled; Gasketing shall be integrated, congruent with architecture, and mechanically fastened with noncorrosive fasteners, or integrated into design of door jamb and head; BHMA A156.22; Gasketing shall be UL listed for use on labeled doors; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

2.9 FABRICATION AND ASSEMBLY

A. General: Fabricate, test, and pre-assemble security door assemblies with hardware at factory; disassemble hardware only to extent necessary for handling, packaging, shipment, and installation at Project. Fabricate metal work to comply with performance requirements. Fabrications shall be rigid, neat, and free from warp/buckle/similar defects, with eased edges and welded joints, ground smooth and flush where exposed to view, to provide continuous, visible flush joints. Welded door seams shall be edge filled and dressed smooth. Weld in accordance with AWS D1.1, Structural Welding Code for Steel, AWS D1.6, Structural Welding Code for Stainless Steel and AWS D1.2 Structural Welding Code for Aluminum.

1. Prepare door leaves and frames of each assembly to receive hardware, devices, and accessory units as shown and scheduled. Reinforce work for hardware and devices and cut work for mortised or concealed units; comply with ANSI A115 series specifications, working from templates supplied by unit manufacturers and suppliers.

a. Locate hardware, devices, and accessories as shown and scheduled (including on approved shop drawings) or, if not otherwise indicated: 1) in accordance with DHI Recommended Locations for Builder's Hardware or, 2) in accordance with security device manufacturer's recommendation for optimum responses, but 3) in any case, as required to achieve required assembly performances. Do not cut or otherwise alter hardware in order to install on door without officially notifying the OBO/SM FE/BR Coordination Team with detail drawings showing/indicating the modification(s) and installation in door along with FE/BR manufacturer’s part number.

b. Except where assembly is equipped with door-seal stripping at jambs and head, provide neoprene door silencers on stops; three at strike jamb for single door, and four at head for double door.

c. Except as otherwise indicated, pre-fabricate and pre-assemble security door assemblies to include full extent of required conduit-protected electrical/electronic power and control wiring placed and supported to avoid conflicts with other elements and subsequent drilling/cutting-in of work during installation of units.
d. Provide access ports, as required, to support general construction 25 mm TSS conduit at door frames and sub-frames/door interface.
e. Clearances between edge of door leaf and frame and edges of door pairs: Not more than 6.5 mm at jambs and head, except between fire-rated pair of doors which shall be as tested.
f. Fabricate frames with horizontally slotted bolt holes to allow for future frame adjustment.
g. Locate and show a path for pneumatic tubing, or door actuator, from entry to the door to the device.

    1) Tubing and wiring location should be coordinated with the anchor holes to minimize pinch risk.

h. Locate terminal block access on hinge side of door frame, between 1.2 meters (47 inches) and 2 meters (80 inches) above the finished floor. The terminal block opening shall have removable cover and provide clear minimum opening of 48 mm (1.9 inch) wide by 250 mm (10 inches) long. Smaller access opening may be provided if access opening is large enough to remove terminal block and it is designed to allow terminal block to hook, or screw, into door and that at least an additional 250-mm of wire is provided, within door, to facilitate removal of terminal block. Any design smaller that reference minimum will also require approval by OBO/CFSM/SM/SCD prior to forced entry/ballistic testing.

    1) Electronic Door Hardware Wiring Diagram: Provide a printed diagram of the factory installed wiring for each electronic device provided with each door assembly. Permanently affix this diagram on the inside of the cover plate that protects the wiring terminal block.
    2) Wires at terminal block shall be labeled properly with electrical door component.

        a) Wiring diagram shall depict conductor number, terminal block number, and wire color for each conductor. It shall also depict which device with model number, as well as which component and polarity of that component that it is connected to. If device is active component such as magnetic lock or access control strike, place voltage of that device on diagram as well (typically 24 volts DC) to ensure that any dual voltage equipment such as some magnetic locks, are pre-configured at factory to 24 volts DC. If device is switch sensor, sensor components may be abbreviated with N.O. for Normally Open, N.C. for Normally Closed, and COM. for common.

    3) Conductor Wire: Each factory installed conductor shall have permanent, numerical, machine labeled identification tag attached to it near termination point so that it is visible when cover plate is removed. These identification

tags shall be sequential in order starting with number 1. Each conductor shall be pre-terminated to factory installed terminal block in sequential order.

4) Terminal Block: Provide terminal block labeled with numerical machine labeled identification tag in sequential order corresponding with appropriate pre-installed conductor.

2. Glazing panels shall be removable without removing door from frame, through top of door or by removing any surface panel, except for as noted within this Article for aluminum doors. Select and size stops, moldings, and anchors to tested design.
3. Glazing panels:

   a. Glazing panels shall be enclosed and cushioned within core of door for continuous perimeter bite of not less than 20 mm on each side, and with 6 mm cushion clearance to fixed metal stop on glazing edges. Glazing panels shall be factory installed with no raw metal edges evident or in contact with glass in door glazing panel openings. Glazing panel opening edges shall be cushioned and trimmed neatly to provide acceptable appearance. Comply with requirements in Section 088855 "Security Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
   b. Additional Requirements for Glazing Panels for Aluminum Doors: External glazing stop frames for aluminum door are allowed only on the interior side of aluminum doors (not allowed on steel doors) on the interior faces of door. See also the Part 2 Article within on MATERIAL, GENERAL REQUIREMENTS FOR ALUMINUM.

4. Sub-frames: Provide steel sub-frames for all FE or FE/BR doors for installation at concrete, masonry, and other non-steel rough openings and for structural steel openings where depth is less than door frame depth. Steel subframe material shall conform to ASTM A36 or ASTM A529 or ASTM A572 for plates, bars, and shapes; and ASTM A500 or ASTM A1085 for hollow structural sections (“steel tubes”). No steel element tapped to receive threaded fasteners shall be less than 12 mm (1/2 inch) thick. For individual openings, sub-frames shall be provided by door supplier. For larger, multi-panel openings, sub-frames may be provided by either door supplier or Contractor; in either case they shall be designed by door supplier and shown with door shop drawings. For larger elevations that require knock-down subframe, provide hot-dipped embeds. Sub-frame depths shall be no less than door frame depth on side of subframe that door is bolted. When embed plate is used in concrete, provide adjustable “mud box” to allow for bolt to penetrate plate and be fully unencumbered. Coordinate sub-frame anchor locations with door frame bolt hole locations. Contractor shall ensure steel sub-frame is assembled and braced so that deformations during installation, or concrete pouring, do not exceed the installation tolerances of the supported door system. Where sub-frames are hot-dipped galvanized, temporary supports shall be designed and detailed not to damage galvanized surfaces during use and removal (e.g., bracing shall not be welded to subframe). Steel sub-frame shall be installed plumb and square. All sub-frames without adjustability shall be drilled and tapped in the field. All door sub-frames shall be pre-punched for technical security conduit.

   a. Post-installed Anchors: In addition to any restrictions or requirements indicated on the Construction Drawings, post-installed anchor systems proposed by the Contractor’s delegated design shall each have ICC-ES Evaluation Report indicating

conformance with current applicable ICC-ES Acceptance Criteria including, but not limited to, for cracked concrete for concrete substrates, seismic applications, and for the use in the specific substrate type and characteristics intended. Shop drawings and field sketches shall clearly indicate critical embedment, spacing, and edge distance requirements and placement tolerances determined by the design.

b. For New Concrete Substrates: Attach steel sub-frame to the concrete substrate with embedded anchors per the blast report, but not less than 12 mm diameter x 150 mm headed steel studs, spaced no greater than 300 mm on center. Provide mud box that incorporates floating anchor to allow minimum of 10-mm (3/8") adjustment in 360 degrees from centerline in each direction of the center of the mounting holes. Floating anchor plates shall be drilled and tapped steel plate, or commercial anchor system, no less than 12-mm thick Final sub-frame shop drawings, product data, and associated delegated design calculations shall be reviewed and approved, in accordance with the Part 1 Article on ACTION SUBMITTALS, prior to fabrication and shipment. Alternative to adjustable mud box system may be considered, but in all case they will need to provide same adjustable connection for the embed and shall take into account the slotted hole adjustability requirements for door frame. Alternative mud box require prior approval by OBO/CFSM/SM/SCD and OBO/PDCS/DE/CSE before door is tested for FE/BR and/or blast.

1) Exterior sub-frames and interior pre-fabricated sub-frames shall be constructed of mild steel 12 mm (1/2 inch) thick steel or greater as required to comply with engineer's report for blast resistance, if applicable, and shall be hot dipped galvanized for corrosion resistance.
2) Field fabricated interior sub-frames shall be prime painted with a high-grade zinc rich metal primer, in accordance with Section 055005 "Metal Fabrications."

c. [For Masonry Substrates: Provide steel sub-frame, typically a plate, tube, or channel that has minimum 12-mm thickness for anchors and minimum width equal to depth of FE/BR product and as determined per blast design, when blast design is requirement. Post-installed chemical anchors in hollow masonry substrates shall use appropriate screen tubes provided by anchor system's manufacturer.]

d. [For Existing Concrete Substrates: Provide steel sub-frame, typically a plate, tube, or channel that has minimum 12-mm thickness for anchors and minimum width equal to depth of FE/BR product and as determined per blast design, when blast design is requirement.]

e. **[Door replacement and retrofit conditions: When FE/BR door is being replaced in kind, existing embed or subframe may be used if visually assessed to be in good condition and determined by calculation to possess sufficient capacity to conform to specified performance requirements for door system. It does not need to be replaced solely because it does not meet one of above 12 mm thickness requirements for new sub-frames. Sub-frame and door hardware design shall provide accommodations for field adjustments to enable installation when verifications in the field prior to fabrication are limited or not feasible. Filling abandoned holes in steel elements with weld material to tap new hole overlapping prior hole is not permitted; drilling and tapping larger**

diameter hole fully encompassing smaller hole is permitted, such as in scenario where existing threads are damaged or determined to be inadequate for new connection design. New anchor holes shall satisfy minimum AISC 360 requirements for bolt hole spacing and edge distances. If subframe does require replacement, as determined by OBO/SM, or due to other conditions (e.g., corrosion or size of opening requires modification), then one of new subframe conditions above shall be used.]

5. Doors, windows and glazed panels in multi-unit elevations shall be designed and fabricated to separate head and jambs of each door frame from other door and/or window frames. Separation shall consist of steel tube, built up section, or bar not less than 25 mm thick, or as required by structural and blast performance requirements; wall thickness of steel tubes shall not be less than 12mm. Material specifications and post-installed anchor requirements as per sub-frame requirements in this Section. Through-bolting door frame through 25mm steel plate into window frame or in reverse order is prohibited.

B. Flashing: Contractor shall provide rigid through-wall flashing at all head locations of exterior doors. Counter flashing is required at locations where building finish materials interface with door systems. Coordinate flashing with FE/BR design at door jambs and sills (when required). Coordinate drip edges at all exterior door heads. Flashing material when it goes all the way through and terminates at interior edge or beyond may have actual thickness excluded when calculating gate/shim space, up to additional maximum of 3 mm beyond allowed shim space.

2.10 DOOR COMPONENTS

A. Glazing Panel: Comply with requirements in Section 088855 "Security Glazing" for performance indicated.

B. Frame to Subframe Attachment: Stainless steel, hot-dip, zinc-coated steel, or iron, complying with ASTM B 633 and ASTM F1941 for fasteners; provide sufficient mechanical properties to comply with the Part 2 Article on PERFORMANCE REQUIREMENTS.

1. All fasteners for doors or windows shall be socket head metric (Class 8.8) equivalent to SAE J429 Grade 5 or other appropriate high strength bolts and hardened nuts and washers as identified in blast report, or as needed to satisfy the Part 2 Article on PERFORMANCE REQUIREMENTS and comply with standard OBO specifications for FE/BR and Blast resistant products. If blast, or other requirements, result in changes to tested FE/BR design, including anchor or other material changes, FE/BR vendor shall contact DS/PSP/RD for to determine if technical review is required. Shop drawings shall include TR number, where applicable. Contractor’s design shall provide appropriate corrosion prevention where dissimilar metals are in close proximity, and to address atmospheric corrosion performance requirements as identified in Part 2 Article on MATERIALS, GENERAL REQUIREMENTS FOR FE/BR DOOR ASSEMBLIES.

2.11 CLADDING

A. Materials: Door cladding and glazing trims shall be fabricated from commercial grade, tension leveled stainless steel to ASTM A240, AISI Type 316, AISI No.4 (brushed) or AISI No. 8 (mirror) Finish as indicated by project specific requirements.

B. Adhesives: Heat resistant, single component, polyurethane reactive (water) hot melt, thermoset adhesive, UL/ULC/WH approved or equivalent industrial grade high-strength/bond double-sided acrylic foam tape.

C. Inter-locking Edge Seams: Resin reinforced polychloroprene (RRPC), fire resistant, high viscosity, sealant/adhesive or UL approved equivalent.

D. Construction: All exposed surfaces of door and frame shall be clad with 1.2 mm (18 gage) commercial grade, tension leveled stainless steel to ASTM A240, AISI Type 316.

1. Door faces shall be fabricated without visible seams, free of scale, pitting, coil brakes, buckles and waves.
2. Direction of grain shall be run with long dimension of piece.
3. Formed edges shall be true and straight with minimum radius for thickness of steel used.
4. Longitudinal edges of base doors clad in stainless steel shall be mechanically inter-locked, adhesive assisted. Edge seams shall be visible.
5. Cladding shall be securely attached to front, back and edges with visible hair-line butted joints at door edges.
6. Lock and hinge edges shall be beveled 3 mm in 50 mm (1/8 inch in 2 inches) unless hardware or door swing dictates otherwise.
7. Cladding installed around electromagnetic lock that is installed on door frame shall allow for lock position to be adjusted 3 mm in both directions.
8. Cladding installed around panic exit device strike plate shall allow for strike plate position to be adjusted 3 mm in both directions.

E. Removable Covers: Fabricate perimeter removable/snap in-place covers from 2.78 mm (0.109-inch) nominal-thickness commercial grade, tension leveled stainless steel to ASTM A167-92b, Type 316 sheet or extruded aluminum. If permanent covers are used provide access holes to all bolts, screws and hardware items. Provide covers for access holes with materials that match the covers/cladding. If covers are attached with screws, provide flush flat hex socket, phillips or torx screw to match cover color. For snap-in-place cover, provide any special tool required to release.

F. Glazing Panel: Where glazing panel is specified, doors shall receive 1.0 mm (20 gage) stainless steel trim and screw fixed glazing stops. Glazing panel trim and stops shall be accurately fitted, butted at corners, with removable stops located on the “push” side of door.

G. Finish Cladded Product Manufacturing Tolerances:

1. Plumbness tolerance, measured through a line from intersecting corner of vertical members and head to floor, shall be +/- 1.6 mm (0.063 inch).
2. Squareness tolerance, measured through a line 90° from one jamb at the upper corner of product, to opposite jamb, shall be +/- 1.6 mm (0.063 inch).

3. Alignment tolerance, measured on jambs, through a horizontal line parallel to plane of wall, shall be +/- 1.6 mm (0.063 inch).
4. Twist tolerance, measured at face corners of jambs, on parallel lines perpendicular to plane of wall, shall be +/- 1.6 mm (0.063 inch).

H. Aluminum Doors are an approved substitution for steel cladded doors, unless specified as "no substitution."

2.12 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

C. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

1. Color: As selected by Project Director/COR with input from the Designer of Record.

D. High-Performance Organic Finish (Fluoropolymer): See Section 099602 "High-Performance FE/BR Coatings."

1. Color and Gloss: As selected by Project Director/COR with input from the Designer of Record.

2.13 METALLIC-COATED STEEL FINISHES

A. See Section 099602 "High-Performance FE/BR Coatings."

1. Color and Gloss: As selected by the Project Director/COR with input from the Designer of Record.

2.14 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

1. At all welds: Remove oxides, carbon precipitation, and weld splatter at or around welded joints and passivate surfaces in accordance with ASTM A380 and ASTM A967.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run grain of directional finishes with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces in accordance with ASTM A380 and ASTM A967. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install security door assemblies in accordance with approved shop drawings, manufacturer's data and instructions, OBO/SM FE/BR Program approved manufacturer's FE/BR Door Installation Instruction Manual, requirements of these specifications, and attached Certificate of Compliance.

B. Complete any assembly that was not accomplished in the shop. Refer to Part 2 Article on FABRICATION AND ASSEMBLY.

C. Anchorage: Door manufacturer shall provide anchors appropriate for substrate to which door frame and sub-frame is to be fastened. Door frames shall have pre-drilled horizontally slotted bolt hole patterns not to exceed 300 mm on center. Contractor shall verify substrates involved, and supply any special fastening tools (e.g., special drill, bit, tap) required by anchoring system and fully comply with Manufacturer's Printed Installation Instructions.

1. Avoid cutting rebar during concrete sub-frame installation.
2. Provide 1.5 mm (1/16 inch) thick plastic shims with break-off tabs, minimum one shim, per socket head cap screw, for subframe rough opening (RO) frame clearance.
3. Match finish of cap plugs used in frame with frame finish to the maximum extent possible. Do not install cap plugs until after 100 percent QA inspection, conducted by OBO/CFSM/SM/SCD/SEB or FE/BR Program representative, of doors has been completed.

D. Repair hot-dipped galvanized surfaces in accordance with ASTM A780, including appropriate surface preparations.

E. Finished Sizes Tolerances of Cladded Doors:

1. Widths of door openings shall be measured from inside of frame jamb rabbets. Allowable tolerances from shop drawings of +1.6 mm, -0.8 mm (+ 0.063 inch, -0.031 inch).
2. Heights of door openings shall be measured from finished floor (exclusive of floor coverings) to head rabbet of frame with tolerance of 1.2 mm (± 0.047 inch).
3. Unless hardware requirements dictate otherwise, finished cladded doors shall be sized to fit above openings and allow 3 mm (0.125 inch) clearance at jambs and head. Tolerances on door sizes shall be 1.2 mm (± 0.047 inch).

3.2 FIELD QUALITY CONTROL

A. Manufacturer's technical representative shall observe and advise the crew during their installation of first three FE/BR doors. Upon completion of installation of each of three initial FE/BR doors, Manufacturer's technical representative shall inspect the work, and direct the crew in any correction or modifications required for acceptable performance of the units.

B. For unique site conditions, Manufacturer's technical representative shall also be responsible for observing and inspecting installation of FE/BR doors, beyond initial three doors, as necessary to ensure that installation crew is adequately prepared for installation.

C. Any anchors or connections that have been stripped or otherwise damaged during installation shall be replaced by the contractor in kind with another larger anchor or an additional anchor provided. In either case, coordinate with the FE/BR vendor and blast designer for doors installed into building with blast protection and provide a plan to address for OBO/CFSM/CM, OBO/DE/CSE, and OBO/CFSM/SM/SEB approval (SEB will coordinate with DS/PSP/PSD/RD when changes could impact the certifications).

1. If alternative anchor locations have been provided for in the design and shown on the approved shop drawings, additional consultation may not be required, but in all cases shall be documented in the deviations portion of the Certificate of Compliance and OBO/CFSM/CM should be consulted.

D. Replace any damaged or defective glazing per the manufacturer’s instructions.

E. Repair any damage done to the door, or finishes, during installation, to include any damage caused by any nearby construction. Provide a plan that has been fully vetted by the manufacturer to repair the product for approval by OBO/CFSM/SM/SEB. OBO/CFSM/SM/SEB will coordinate with DS/PSP/PSD/RD when repair could impact the FE or FE/BR certifications.

3.3 ADJUST AND CLEAN

A. General: Upon request of Project Director/COR, remove protective coverings and clean exposed surfaces. Repair damaged elements, restore abraded surfaces, touch-up base-coat paint finish with air-drying primer, and remove imperfections from exposed natural metal finishes.

1. Check and readjust hardware, devices, and accessories with door-to-frame-and-sill/ threshold clearances set for proper operation of locks, door seals, and other operational units. Do not remove permanently applied performance labels.
2. Comply with Section 087155 "Security Door Hardware" requirements for protection and handling of keys, locking devices, and associated information.
3. Exercise extreme care in cleaning exposed surfaces of glazing; comply with manufacturer's directions.
4. Ensure all debris is removed from the threshold area.

B. Paint touch-up paint: See Section 099602 “High-Performance FE/BR Coatings.”

END OF SECTION 083454

Certificate of Compliance

FE/BR Door Assemblies
Door Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the FE/BR products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

DESCRIPTION – TRAINING & OTHER DUTIES OF TECHNICAL REPRESENTATIVE

1	The manufacturer's technical representative was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing door assemblies has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.	**Representatives Name/ Date:**

	DESCRIPTION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	Verify no damage has occurred to crate during shipping, no 'tip-and-tell' devices are tripped, and BOM (Bill of Materials) is accurate.		
3	Each sub-frame has been installed level, plumb and square.		
4	All sub-frame assemblies were factory welded, and any large sections that exceed limits of standard shipping containers were clearly identified for field welds.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
5	All units with glazing panels were pre-glazed at the factory.		
6	Employees performing installation meet specified training and experience qualifications.		
7	Each door frame head was installed level, and side jamb installed plumb and square.		
8	All frame socket head cap screws and threaded openings in sub-frame were cleaned of all oil and debris, were dry-torqued to meet manufacturer's specifications, and were centered in slotted door frame holes so that slotted hole is visible on both sides of washer. Shims were inserted at all socket head cap screw locations.		
9	Frame screws are manufacturer supplied in accordance with approved shop drawings. Deviations from this shall be submitted through Project Director/COR to OBO/CFSM/SM FE/BR Coordination Board for their technical review and approval during shop drawing review phase. **a. [Existing Door Replacement: Whenever possible, same screw size and pattern may be used. When existing FE/BR door is being replaced, existing screw may be 12mm diameter screw, and washer grade 8 or equivalent class 10.9 or 12.9 historically used in past. In coordination with OBO/SM, replacement door may use this same attachment.]**		
10	All door frame shims are plastic or stainless steel, horseshoe shaped, and 1.5 mm (1/16") thick with break-away tabs.		
11	Shim: All door socket head cap screws were installed and fully shimmed, minimum one shim per screw. Shim gap may exclude through wall flashing and weather proofing up to an additional 3-mm beyond the 6.5 mm, or the as tested gap limits referenced in this section (i.e., gap at the head could be 6.5 mm, plus 3 mm for a drip edge and through wall flashing for a		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
	total gap of 9.5 mm, or as tested, at the head or if the weather proofing was thinner, the total allowable gap would need to reflect the weather proofing plus 6.5 mm, or as tested gap space)		
12	In no case shall the combined tested gap and weather proofing exceed 12-mm between subframe and the door frame.		
13	Doors may be mounted maximum of 6.5 mm proud of subframe on attack side.		
14	Door frame socket head cap screw horizontal slotted holes are 19 mm x 35 mm (3/4 inch x 1-1/4 inch) radiused access holes. Washers shall be 27 mm diameter. **a. [Existing Door Replacement: Slotted holes may match existing]**		
15	At each door assembly, there is continuous, plus or minus 1.5 mm (1/16 inch), gap between door leaf and door frames, as indicated in FE/BR manufacturer's shop drawings.		
16	Door does not bind on surrounding floor area and provides minimum of 6 mm of clearance between door leaf bottom and floor at any point in door swing after final floor finish has been applied.		
17	Aluminum threshold cover plates were installed, and do not exceed limits for accessibility in accordance with OBO Building Code Chapter 11, and as indicated in approved shop drawings.		
18	Weather proofing and flashing is installed through the frame and terminated as shown on the approved shop drawings.		
19	Door Under cuts: a. If there is a threshold, the undercut between the bottom of the door and the top of the threshold shall not exceed 6 mm. Distance between the bottom of the door and the floor slab should not exceed 19mm including threshold.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
	b. If there is no threshold, the undercut between the bottom of the door and the top of finish floor shall not exceed 6 mm and shall not exceed 12 mm for carpet (top of finish slab to bottom of the door).		
20	Ballistic trim bars have been screwed to sub-frame and not door frame, and as shown on approved shop drawings. Maximum gaps at shim space shall not exceed as tested. a. Ballistic trim shall be designed to take into account dimensional requirements of flashing or weather proofing. b. Ballistic trim shall be tight to the subframe. c. Ballistic trim shall be tight to the door frame and a construction tolerances of up to a maximum of 3 mm is acceptable between the frame and ballistic bar.		
21	The door is to be installed plumb and in accordance with approved tested assembly and shop drawings.		
22	All forced entry lock (FEL) strikes engage their strike plates with no binding.		
23	No part of FE/BR door has been altered. No part of FEL has been altered, including but not limited to grinding, bending, cutting or re-welding any part of FEL strike, strike plate (steel coupon with vertical slot welded or screwed to frame) and (if applicable) strike plate receiver (vertical slot in door leaf). The only acceptable fix for defective or altered parts is to unbolt altered piece and replace altered piece in its entirety.		
24	No finish materials including exterior cladding or interior trim overlaps door frame/subframe gap and ballistic trim bars unless finish materials can be easily removed and reinstalled. Any overlapping finish work (i.e., metal, wood, stone, gypsum board, etc.) must be capable of removal without damaging door frame and surrounding finish work. Door and frame were installed such that removal of door and frame is possible without demolishing		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
	finishes and trim, allowing door frame to be adjusted in future, 6 mm in or out of opening.		
25	Any cladding that covers door frame screw access holes has either access holes with cap plugs or is attached with screws for easy removal without damage for reinstallation. Cap plugs and cladding for each door have been bagged and will not be installed until after final QA inspection has been conducted by OBO/SEB or FE/BR representative.		
26	Manufacturer and installer ensures any decorative cladding around electromagnetic locks installed on door frame will allow lock position to be adjusted in both directions.		
27	All access plates for each door have been installed as indicated in approved shop drawings.		
28	Each lockset, deadbolt and panic exit device is able to fully engage and freely operate.		
29	On doors with panic hardware, panic exit device strike plate has been installed in location that will eliminate any door leaf bounce between door leaf and frame.		
30	Each door closer has been installed and closing speeds, latching speeds, and back-check has been adjusted in accordance with manufacturer's instructions. Doors shall close and latch in 5-7 seconds.		
31	Automatic door operators have been adjusted as appropriate in accordance with manufacturer's instructions to conform to accessibility and fire protection requirements of the OBO Building Code.		
32	Manufacturer has provided two embossed/ printed metal plate or metallic foil for each product using machine-applied letters and numbers with raised characters. Locate one label on door frame header so that it is not exposed when door is closed and is clearly visible and not obscured by hardware when door is open. Locate second label on top edge of door leaf.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
33	Inspect glazing for distortion, defects and/or damage. Defective units, including spall liner damage, do not meet DS certification requirements and must be replaced.		

Installer Team Lead:	**Contractor's QC Manager:**
Printed Name: _____	Printed Name: _____
Signature: _____	Signature: _____
Initials: _____	Initials: _____

Noted Variances:

_____

_____

_____

_____

_____

_____

_____

DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

_____

_____

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_____

_____

[1] [2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

SECTION 083459 - VAULT DOORS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies proprietary, high-security, preassembled door-and-frame units, fabricated to recognized standards for burglar resistances, and including proprietary finishes and accessory items such as door hardware and devices.

1. Where indicated, units include manufacturer's standard day gates or day doors.

B. [Definitions and Roles for Projects Utilizing the GPE Program:

1. GPE Program: A program of the Overseas Buildings Operations (OBO) in which OBO procures security doors and windows in advance of and for the use of upcoming projects. All GPE windows and doors shall be designed and engineered prior to award of the project to the Contractor.
2. Fabricator: This entity is the fabricator/manufacturer of GPE items.
3. Manufacturer: This entity is the manufacturer/fabricator of GPE items.
4. **Contractor: The Contractor is responsible for the design incorporation, delivery and installation of the GPE products. The Contractor is also responsible for the design and construction of the overall facility, as well as the installation of the GPE items selected by the Contractor in conformance with the overall requirements of the project. The Contractor is responsible for development of a GPE product list and submission of the list to the government for approval, with the design development drawings.]**

C. Related Sections include the following:

1. Section 033000 "Cast-in-Place Concrete" for interfacing support floor/wall construction adjoining vault door assemblies.
2. Section 087155 "Security Door Hardware" for lock cylinders and other devices to be installed on units of this section.
3. Division 08 Sections for custom metal security doors rated for forced entry, ballistics and other security resistances.
4. Division 28 Sections on building control/security systems for required integration of vault door controls.
5. Other sections of these specifications for interface of door hardware and device units, with alarm/security/safety/access/monitoring systems; not work of this Section.

1.2 ACTION SUBMITTALS

A. General:

1. Action submittals should be accepted by the PD/COR (Government Project Director/ Contracting Officer Representative) prior to procurement of associated items by Contractor; premature procurement is at the risk of Contractor.
2. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Product Data:

1. Product data, for each fabricated door unit and associated auxiliary equipment, hardware, devices, and trim; include fabrication/installation drawings, and details of required interfaces with other work and services.

C. Certificates and Approvals:

1. Provide a Certificate of Compliance with supporting data sheets demonstrating vault door assembly is in accordance with the Part 2 Article on PERFORMANCE REQUIREMENTS.
2. Letter from DOS indicating certification that the product has been certified by Bureau of Diplomatic Security (DS) in accordance with this article, as applicable.
3. Letter from manufacturer including a copy of the GSA listing approval on the GSA qualified Product List (QPL) for Class 5 security vault door per this article.

D. Shop Drawings:

1. General:

a. Show each dimensioned detail of each door assembly.
b. Indicate performance rating, swing, hardware set, and adjacent construction. Shop drawings must also clearly indicate all hardware sets.
c. Provide drawings on B-size (297 mm x 420 mm) sheets. All dimensions shall be indicated in metric. Show typical door exterior elevations at not less than 1:20 scale.
d. Submittals in PDF format: Provide Table of contents and bookmarks organizing by building and floor for each product using contract identification number.

2. Cover sheet: Include manufacturer's name, address, telephone, and facsimile numbers; customer and address; project location; contract or purchase order number; and submittal release record.
3. General Notes and details sheet:

a. Terminal strip size, location, and height above bottom of door frame for the day door.
b. Fasteners and anchor at location and sizes per certified and tested condition.
c. Identify exact location on door and frame of two required ID plates; see the Part 1 Article on IDENTIFICATION SYSTEMS. Identify plate type and size, and type of information included on the plate about door.
d. TSS Wiring (Terminal #, Terminal Wire, Device Wire, Function, Device Model & Device Type) and Elevation and Detail Drawings (day Gate or Day Door).
e. Abbreviations used.
f. Provide a list of any special fastening tools for installation and maintenance.

4. Unit information:

a. Manufacturer's model number.
b. DOS Code number.
c. GSA Code and/or Model number.

1) Provide “Class” designation per GSA AA-D-600.
2) Provide “Type” designation per GSA AA-D-600.
3) Provide “Style” designation per GSA AA-D-600.
4) Provide “Design” designation per GSA AA-D-600.

d. Mark (door no.).
e. Door/frame finish.
f. Door type.

5. Elevation Drawings (Attack side):

a. Rough opening dimensions.
b. Door opening dimensions.
c. Frame opening dimensions.
d. Vision opening dimensions (per contract drawings for day doors/gates).
e. Door ballistic peep, as applicable.
f. Substrate/rough opening material.
g. Finished floor.
h. Sill condition.
i. Manufacturer's name and reference numbers for primer and finish paint, including number of coats applied.
j. Detail symbols.
k. Hardware and hardware symbols. Include part numbers, manufacturers, and description.
l. Electrical access, for day doors.
m. Location of conduit or cable entry into the door frame, as applicable, for day gate/door and location of any TSS (surface mounted) for the vault door.
n. Total weight of the door to include frame, and all hardware.

6. Plan Drawings:

a. Relate to elevation on drawing.
b. Identify "Attack" and "Protected" sides.
c. Provide AA-D-600 “type” (IR, IL, IIR, IIL).
d. In addition to AA-D-600 “type” identify door swing of all vault doors, day doors and day gates (i.e., RH, LH, RHRB, LHRB).
e. Provide key notes on drawings.
f. Indicate room space numbers taken from Contract Drawings.

7. Details: Show section at 1:5 scale of members indicating construction, size, and thickness of components. Details shall be on separate sheets from plan and elevations

a. Frame profile, anchorage.
b. Threshold configuration.

c. Day door glazing panel together with connections,
d. Section through the door that shows the vertical and horizontal rails, glazing, and glazing stops for day doors.
e. Fasteners.
f. Shims.
g. Flashing, sealant, backer rods, gaskets for exterior doors.
h. Undercut for carpet for day doors.
i. Acoustic gasketing (day door).
j. Door and frame thickness.
k. Detail shall include contract drawing information of "products by others" such as conduit location for TSS (door control for day gates or day doors and alarms).

8. General Product Information: Include notes sheet, miscellaneous materials specifications, abbreviations, finish/paint system, legend, and glazing specifications.
9. Installation Instruction Manual:
10. Manual shall cite all anchorage components, including complete description of anchors, as well as installation.
11. Manual shall be customized for each type of application.
12. Manual shall include installation steps of contract drawing information of "products by others" such as TSS component for the day door or day gate.
13. Develop instructions for unique conditions as they are identified.
14. Manual shall include step-by-step instructions for installing vault, day gate and day doors with supporting photos, illustrations and figures that also includes sections for General Requirements and manufacturer's recommendations for safety, personal protection equipment (PPE), List of Tools & Expendable Supplies, Door Removal from Crate, and Cleaning.

1.3 CLOSEOUT SUBMITTALS:

A. General:

1. Refer to Division 01 Sections on Submittals and on Closeout for general administrative requirements.

B. Special Warranty: Provide special warranty in accordance with the Part 1 Article on WARRANTY.

C. Maintenance Data.

1. Data shall include instructions for cleaning and maintenance.

D. Inspection Reports and Certificate of Compliance: See forms at end of this Section.

1. Provide Table of contents and/or bookmarks organizing by building and floor for each product using contract identification number.
2. Provide plan showing location of products (one plan may cover multiple products or whole floor if legible).

3. Provide completed certificates of compliance documenting that each vault door assembly has been installed in accordance with contract documents. Signed by certified factory trained installer.
4. Provide any additional QC documents used by Contractor during the installation.

1.4 QUALITY ASSURANCE

A. The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the Vault door products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager.

1. The Installer team leader trained the installation crew and supervised the installation of the vault door assembly.
2. GSA label is attached to exterior of the door.
3. Manufacturer Identification Label is attached to interior of the door.
4. Manufacturer Serial number plate is permanently attached to exterior (non-removable fasteners).
5. Spare parts list is attached to the inside face of the door frame.
6. All observable surface finish shall be free of cracking, flaking, rust, or scale.
7. The door and frame shall be in perfect alignment and operation of the locking mechanism, including the locking bolts, shall be smooth and positive without binding or jamming of parts.
8. Door shall be installed true, plumb, square, level, and balanced.
9. Door reveal shall be equal (within 1/8") on all sides and at least 1/8" wide
10. Door remains at any position set and does not move on its own when placed in any position.
11. Door is free of any on-site modifications or additions.
12. The door shall not stick or jam in its frame.
13. Dial ring is securely fastened without movement or side play.
14. Optical door viewer shall be firmly attached and free of cracks, scratches or blemishes.
15. Lock shall operate smoothly without binding or jamming.
16. Emergency escape mechanism shall operate properly.
17. All surfaces have manufacturers finish or have been rectified in accordance with federal specification AA-D-600.
18. The door handles shall be without burrs, nicks, scratches, and sharp edges.
19. The door pull shall be securely and firmly attached to both the door front and the door interior.
20. Throw bolt handles shall be firmly attached to the front of the door.
21. A door stop to prevent the door's face hardware from striking wall surfaces shall be installed. The stop shall be able to withstand hard usage. The stop shall not scratch or scar the door's painted finish when the door is swung open against it.
22. The fit of the door to the striker on both the front and hinged edges shall be such that there is not more than 1 mm play or shake in the door when the bolts are thrown to the locked position.
23. The back plates shall be firmly and securely fastened to the door. The plates shall not be sagging, bulging, or distorted. All fasteners attaching the plate shall be present.
24. All lock or door manufacturer recall or service bulletins have been addressed.

1.5 IDENTIFICATION SYSTEMS

A. Identify each assembly to provide the Government with ready reference to original manufacturer to facilitate reorders, replacement parts, service, resolution of complaints, and inventory.

1. Provide labeling as required by Government Federal Specification AA-D-600-Latest Version.
2. Provide DOS identification labels for each door assembly. Labels shall be embossed/printed metal plate or metallic foil with adhesive backing for permanent identification. Locate one label on door frame and another adjacent to GSA label on the inside of the door. Labels shall cite:

   a. Manufacturer's name/city/state.
   b. Month/year of manufacture.
   c. Mark number.
   d. DOS government certification model number. (as applicable).
   e. DOS Code (i.e., 1123, 2123, etc.).
   f. SHW Hardware package number/Modification number (as applicable).

1.6 DELIVERY, STORAGE, AND HANDLING

A. To the extent practicable, deliver vault door units to the project as completely assembled doors, frames, hardware, devices, trim, and associated auxiliary equipment. Comply with Government criteria and manufacturer's recommendations for packaging, handling, protection, storage, and delivery. Disassemble and reassemble at project site only to the extent necessary for proper handling and installation.

1. Store doors, materials, other than fabricated steel, in weather tight containers until ready for use in work. Store containers in dry place.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Failure to meet performance requirements.
   b. Structural failures including excessive deflection.
   c. Deterioration of metals, other materials, and metal finishes beyond normal weathering.
   d. Failure of hardware components.

2. Warranty Period:

   a. Doors: Manufacturer will warrant the doors for a period of five years from Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Vault doors used by the Department shall be GSA approved Class V and listed on GSA's Qualified Product List.

B. Vault doors may also require Department FE/BR Certification for use in Department facilities (depending on location and/or use). Vault doors requiring FE/BR Certification shall be listed on the FE/BR Approved Product List and a Certification Letter will be issued to the vault door manufacturer with a unique DOS Model Number specific to each vault door type.

DOS Door Codes: See Table 2.1 "Door Codes" below:

TABLE 2.1 – DOOR CODES

DOS CODE	1st DIGIT - TRANS-PARENCY	2nd DIGIT - FIRE RATING	3rd DIGIT - FORCED-ENTRY RATING	4th DIGIT - BALLISTIC-RESISTANCE RATING
1	Transparent	None	None	None
2	Opaque	1.5 hours (class D at exterior)	15 minutes	Note Used
3	*	3 hours (class A)	60 minutes	Rifle 5.56 & 7.62 NATO
4	*	45 minutes (class C)	5 minutes	Armor-Piercing (.30-06)

Notes for above Table 2.1:

1. Composition - Column 1: Designated whether door has a transparency.
2. Fire Rating - Column 2: Fire-rated assemblies: Where indicated for fire resistance, provide flush steel doors-and-frame units; comply with NFPA 80, Standard for Fire Doors and Windows. Provide units that have been tested by recognized testing agency in accordance with NFPA No. 252 and ASTM E 152. Provide rated units where shown or scheduled.
3. Forced Entry Rating - Column 3: Forced-Entry (FE) resistant assemblies: Where door assembly is shown or scheduled as FE, provide door manufacturer's material and fabrication for panels, inserts, hardware, devices, and framing of units for the ratings as noted above.
4. Ballistic Resistance Rating - Column 4: Ballistic resistant (BR) assemblies: Where door assembly is shown or scheduled as BR, provide door manufacturer's materials and fabrication for panel, inserts, and framing of units for the ratings as noted above.

C. Vault door procurement shall comply with all applicable GSA requirements and DOS procurement and shipping requirements in accordance with Division 01 specifications.

1. Provide GSA Class 5-V or GSA Class 5-B security vault door meeting Government Federal Specification AA-D-600 most recent revision as required in the contract documents.

D. Certified Units: Provide units, including frames and sub-frames (if applicable) which meet the following requirements:

1. Have been certified by Bureau of Diplomatic Security (DS) in accordance with DS/PSP/PSD SD-STD-01.01, Revision H.
2. Have been approved by GSA as a GSA Class 5-V or Class 5-B security vault door meeting Government Federal Specification AA-D-600-Latest Version and listed on GSA's Qualified Product List (QPL), QPL-AA-D-600-Latest Addition.

2.2 MANUFACTURERS

A. Selection of fabricator/manufacturer for each type of security door assembly, and selection of manufactured elements, which are used in make-up of that assembly, are Contractor's options subject to the following requirements and limitations, and subject to general provisions of Construction Contract:

1. Pre-certified fabricators (by DS) of ballistic-resistant and forced-entry-resistant assemblies are identified in a separate Contract Attachment labeled "Government Certified FE/BR Products and Designs".

2.3 MATERIALS/PRODUCTS/FABRICATION

A. General: Provide manufacturer's standard vault door unit construction/fabrication as specified, including sizes, features, hardware, devices, trim, and associated auxiliary equipment as indicated, and as necessary to fulfill performance requirements of Part 1 of this Section.

1. Clear Door Opening: 1015 mm (40 inch) wide by 1980 mm (78 inch) high nominal clearance, with door swung 180 degrees open, except as otherwise indicated. Spreader: Provide steel spreader permanently attached to bottom of frame.
2. Types: Provided Type in compliance with GSA Specification AA-D-600 and the project door schedule.
3. Viewer: Provide manufacturer's standard viewing port at approximately 1525 mm above finished floor.
4. Styles: Provide Style E – Electromechanical combination in compliance with GSA Specification AA-D-600
5. Design: Provide Design in compliance with GSA Specification AA-D-600 and the project door schedule.
6. Threshold/Sill Arrangement: Manufacturer's standard operational, recessing floor plate or threshold, with vault door not more than 12.7 mm above finished floor outside of vault.
7. Vault hardware: Equip vault door to include day gate or day door (as applicable) unit with hardware as indicated on schedule and in project specifications for door hardware.

8. Day Gate: When in door schedule provide Day gate accessary with specified hardware. Provide inward swinging gate with minimum 11 gauge mesh and frame to accommodate hardware. Day gate shall be self-closing and not restrict the clear opening of vault door. Color to match vault door.
9. Day Door: When in door schedule provide Day door accessary with specified hardware. Provide an inward opening, gasketed, with two viewing windows that have a minimum size of 765 mm x 652 mm to view personnel attempting entry into the space. The door shall be a non-fire rated door assembly used for smoke control under NFPA 105. The gasketing of the day door is to ensure that there is minimal leakage from the inside of the door to the outside of the door. Day door shall be self-closing or have a closer and not restrict the clear opening of vault door.

    a. Acoustic day door: The door must conform to acoustic requirements of the wall and room door is installed in as shown on drawings. This is to include the door, frame and any connections or provide inner vestibule door and partition wall to meet requirements. If day door assembly can not meet acoustic requirement design must provide inner vestibule door and partition wall to match requirements if space is available.

10. Door/frame finish: Shop coat exposed surfaces of door and frame with one coat of gray color 26134 texture paint, AMS-STD 595 (Aerospace Material Specification Standard 595) in compliance with AA-D-600

2.4 ANCHORAGE PROVISIONS

A. General: Fabricate vault door assemblies with manufacturer's standard provisions for anchorage of units into wall and floor construction work as indicated and as required to maintain resistance ratings.

B. All anchorage, to include sub-frame, shall be in accordance with GSA Specification AA-D-600.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Except as otherwise indicated, comply with approved shop drawings and vault door manufacturer's instructions for installation of door unit assemblies including handling, placing, temporary bracing, and protection. Comply with GSA requirements and recommendations for methods of achieving and maintaining overall vault resistance ratings through proper installation of work. Achieve required performance ratings where these may be dependent upon installation work.

1. Set vault door assemblies plumb and level, true to line and location as shown. Provide anchorage and other devices as indicated and as required.

2. Install combination locking mechanism, and test operate construction-phase combination at least three times to assure proper installation. Advise Project Director/COR that vault door assembly is ready for implementation of initial operational combination of locking mechanism.

B. Complete any assembly that was not accomplished in the shop. Refer to Part 2 Article on FABRICATION AND ASSEMBLY.

C. Operate and demonstrate to Project Director/COR the following: Vault door threshold/ sill/floor plate leveling arrangement, swing of door, and locking bar operation.

3.2 ADJUSTING AND CLEANING

A. General: Adjust vault door operating elements for ease of operation; lubricate in accordance with manufacturer's instructions. Remove protective covering from finished metal surfaces, and clean in accordance with manufacturer's instructions. Touch up minor imperfections and abrasions of finishes and coatings.

END OF SECTION 083459

Certificate of Compliance

Vault Door Assemblies
Vault Door Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the FE/BR products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

VERIFICATION – TRAINING & OTHER DUTIES

1	The Installer team leader trained the installation crew and supervised the installation of the vault door assembly.	**Installer Team Leader's Name/ Date:**

	VERIFICATION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	GSA label is attached to exterior of the door.		
3	Manufacturer Identification Label is attached to interior of the door.		
4	Manufacturer Serial number plate is permanently attached to exterior (non-removable fasteners).		
5	Spare parts list is attached to the inside face of the door frame.		
6	All observable surface finish shall be free of cracking, flaking, rust, or scale.		
7	The door and frame shall be in perfect alignment and operation of the locking mechanism, including the locking bolts, shall be smooth and positive without binding or jamming of parts.		

	VERIFICATION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
8	Door shall be installed true, plumb, square, level, and balanced.		
9	Door reveal shall be equal (within 3mm [1/8”]) on all sides and at least 3mm [1/8”] wide		
10	Door remains at any position set and does not move on its own when placed in any position.		
11	Door is free of any on-site modifications or additions.		
12	The door shall not stick or jam in its frame.		
13	Dial ring is securely fastened without movement or side play.		
14	Optical door viewer shall be firmly attached and free of cracks, scratches or blemishes.		
15	Lock shall operate smoothly without binding or jamming.		
16	Emergency escape mechanism shall operate properly.		
17	All surfaces have manufacturers finish or have been rectified in accordance with federal specification AA-D-600.		
18	The door handles shall be without burrs, nicks, scratches, and sharp edges.		
19	The door pull shall be securely and firmly attached to both the door front and the door interior.		
20	Throw bolt handles shall be firmly attached to the front of the door.		
21	A door stop to prevent the door's face hardware from striking wall surfaces shall be installed. The stop shall be able to withstand hard usage. The stop shall not scratch or scar the door's painted finish when the door is swung open against it.		
22	The fit of the door to the striker on both the front and hinged edges shall be such that there is not more than 1 mm play or shake in the door when the bolts are thrown to the locked position.		

	VERIFICATION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
23	The back plates shall be firmly and securely fastened to the door. The plates shall not be sagging, bulging, or distorted. All fasteners attaching the plate shall be present.		
24	All lock or door manufacturer recall or service bulletins have been addressed.		

Installer Team Lead:	Contractor's QC Manager:
Printed Name: _____	Printed Name: _____
Signature: _____	Signature: _____
Initials: _____	Initials: _____

Noted Variances:

_____

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_____

DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

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_____

_____

_____

_____

[1] [2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

SECTION 084414 – STRUCTURALLY-FRAMED SECURITY CURTAIN WALL SYSTEM

GENERAL

1.1 SUMMARY

A. The extent of aluminum security curtain wall system is indicated on Construction Drawings by elevations/details/schedules/notations.

B. Related Sections include the following:

1. Division 01 Section "Secure Shipment."
2. Division 05 Section on structural steel framing.
3. Section 055005 "Metal Fabrications."
4. Division 07 Section on joint sealants.
5. Section 080001 "Blast Requirements."
6. Section 083454 "Forced Entry (FE)/Ballistic Resistant (BR) Door Assemblies" for Quality Control forms on FE/BR products.
7. Section 088855 "Security Glazing."
8. Section 099602 "High-Performance FE/BR Coatings."
9. Other sections of these specifications for interface of laminated glazing unit, framing, and other hardware with alarm/security/safety/access-monitoring systems, where required.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 Contract Specification Sections:

B. Product data for curtain wall system. Include high-performance laminated plastic glazing, structural steel framing and supports, metal floor plates and gratings, miscellaneous steel attachments and anchors, and aluminum trim. Include Project Director/COR's detailed instructions for assembly, protection, installation, and maintenance.

C. Completed certificates of compliance documenting that all assemblies have been installed per the contract documents. Complete and submit to the Project Director/COR the form referenced in the Part 1 Article on QUALITY ASSURANCE. Certificate of Compliance form is found at end of this Section.

D. Shop drawings showing dimensioned detail of curtain wall system, including performance rating and adjacent construction. Show application of intended glazing materials. Show interior and exterior elevations of curtain wall system at not less than 1:20 scale. Indicate how curtain wall system, not necessarily including basic sub-frames, may be subsequently removed/replaced; and how laminated glazing removal/ replacement is to be accomplished. After final modifications and corrections have been incorporated, submit drawings as AutoCAD files with .DWG extension. Show the following:

1. Cover sheet: Include manufacturer's name, address, telephone, and facsimile numbers; customer and address; project location; contract or purchase order number; and submittal release record.
2. Unit information:

    a. Manufacturer's product identification
    b. Government code.
    c. Trim/frame finish.
    d. Laminated glazing unit number
    e. Government certification number.

3. Elevation Drawing: Show fabrication and installation details for the entire shielding assembly. Include plans, elevations, sections, and details of laminated glazing units, support, and connections. Show anchorage and accessory items.
4. Plan Drawings:

    a. Relate to elevation on drawing.
    b. Identify "Attack" and "Protected" sides.
    c. Provide key notes on drawings including room space numbers where appropriate.

5. Details: Show sections at 1:5 scale of members indicating construction, size, and thickness of high-performance laminated glazing, structural steel framing and supports, metal floor plates and gratings, miscellaneous steel attachments and anchors, and aluminum trim. Details shall be on separate sheets from plan and elevation drawings. Clearly illustrate all aspects of curtain wall system including:

    a. Relationship of curtain wall to the building structure, roofing and waterproofing systems, interior finishes, and other adjacent construction.
    b. Arrangement of components.
    c. Sequence and details of fabrication, assembly, and erection.
    d. Full size details, indicating: sealing, flashing, weeping, and jointing; all dimensions and thicknesses; materials and finishes; material, type, size, location, and spacing of screws, bolts, welds, anchoring devices, and glazing accessories; locations of conduit entry into both subframe and window frame (where applicable).
    e. Details shall include all components, fully coordinated and integrated, regardless of the component provider.
    f. Include details of all connections and seals to contiguous work as approved by Subcontractor for the work adjacent, and include all assumptions regarding tolerances of that work.
    g. Details shall be on separate sheets from plan and elevation drawings.
    h. General Product Information: Include notes sheet, miscellaneous materials specifications, abbreviations, finish/paint system, legend, and glazing specifications.
    i. Breakdown of Product Line Items:
    j. If Manufacturer produces one contract line item as several parts, they shall break out items on drawings. Each item shall be a subdivision of that product line item number. Indicate manufacturer’s part numbers for all components,

E. Blast Report: See Section 080001 "Blast Requirements."

F. Test Reports: Curtain wall manufacturer shall submit two copies of all ASTM and UL test reports for each product.

G. Installation Manuals: Curtain wall manufacturer shall submit two copies of the installation instruction manuals for each product.

H. Delegated-Design Submittal: For aluminum curtain wall system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of curtain wall and structural frame.
2. Include design calculations.

I. Sequence of Construction: Outline proposed method and sequence of construction for the system, including both structural steel framing and associated window units. Obtain acceptance by the Project Director/COR prior to delivering material to jobsite.

J. Coordinate construction submittals of this Section with those for associated structural framing. The structural framing submittals shall:

1. Welding certificates.
2. Fabrication drawings, including details.
3. Structural Steel Quality Control Procedures: Structural Steel Fabricator/Erector shall submit quality control procedures. Include minimum procedures identified in the Part 1 Article on QUALITY ASSURANCE, along with other procedures necessary to assure that fabrication work being performed and material or products being furnished, conform to Contract Documents.

1.3 QUALITY CONTROL

A. Testing Laboratory Qualifications: For testing compliance with non-security performance requirements on curtain wall system, use only those testing laboratories which have successfully demonstrated to Project Director/COR that they have experience and capabilities needed to satisfactorily conduct required tests.

B. Quality Control for Products: Certificates for fabricated and assembled products specified in this Section shall follow quality control procedures established by the Government; see the QA for assemblies within Section 084414, "Structurally-framed security curtain wall system."

C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice and licensed within any of the States in the United States, and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar in material, design, and extent to those indicated for this Project.

D. Laminated glazing shall be certified by manufacturer for conformance with special quality and performance requirements.

E. Installers: Installers shall be certified by the manufacturer to ensure conformance to special requirements for product installation.

F. Preconstruction Mockup: The pre-construction mockup shall be constructed at the test facility. In addition to testing all required tests, the mockup shall also provide fabricator an opportunity to demonstrate to DOS how curtain wall system is constructed on site, and complies with requirement that the system is glazed in the factory and the windows, with frames, are delivered as sealed units.

G. Construct mockup of curtain wall system at project site. Mockup shall be minimum 3 meters by 3 meters (10 ft. by 10 ft.), or to mockup configuration and dimensions indicated in Drawings. Mockup will be used as basis of design for installation and acceptance, and must demonstrate full constructability of system and all surrounding building components for curtain wall system.

H. Manufacturer's Technical Representative: Manufacturer's technical representative shall have the following responsibilities, and their services as identified below shall be provided by Contractor at no cost to Government:

1. Pre-Installation Conference: Before beginning installation of curtain wall system, Manufacturer's Technical Representative shall conduct pre-installation conference at Project site with installation sub-contractor, electrical sub-contractor, Project Director/COR, and other interested parties, as identified by the Contractor and by the Project Director/COR, to review installation procedures and manuals, schedules, and coordination of curtain wall system installation with other elements of the Work

2. Inspection: Manufacturer's Technical Representative shall observe and advise crew during initial installation of first three laminated glazing units of curtain wall system. Upon completion of initial installation, Manufacturer's Technical Representative shall inspect the work and direct crew in any correction or modifications required for acceptable performance of system. For unique site conditions, Manufacturer's Technical Representative is responsible for observing and inspecting installation of curtain wall system beyond initial installation, as necessary to ensure that installation crew is adequately prepared for installation.

3. Additional Assistance: Manufacturer's Technical Representative shall provide the Contractor any additional advice, instruction, training, supervision, or inspection required to enable Contractor to complete installation certification described below, and to fully train Embassy staff in proper maintenance of curtain wall system.

I. The Contractor shall complete Certificates of Compliance in full prior to acceptance of the Blast products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by Installer Team Lead and Contractor's Quality Control Manager. The following requirements associated with CERTIFICATION BY GENERAL CONTRACTOR are part of this Section.

1. The manufacturer's technical representative was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing door assemblies has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.
2. Employees performing the installation meet the specified training and experience qualifications.
3. Each sub-frame has been installed level, plumb and square.
4. All sub-frame assemblies must have been factory welded together.
5. All temporary bolts have been replaced with permanent bolts.
6. All frame bolts and threaded openings in subframe have been cleaned of all oil and debris. All frame bolts have been torqued to manufacturer’s specifications. Shims have been inserted at all bolt locations.
7. All product bolts, screws and anchors are metric products.
8. No finish materials overlap the window frame/sub-frame shim space and ballistic trim bars unless the finish materials can be easily removed and reinstalled. Any overlapping finish work (i.e., metal, wood, stone, etc.) must be capable of removal without damaging the window and finish.
9. Any removable trim covers that cover window glazing stops (angles or tubes) is attached to the frames with screws or clips for easy removal.
10. Any removable trim covers that cover the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cladding for each window won't be installed until after the final QA inspection has been conducted by the OBO/CFSM/SM/SCD/SEB representative.
11. The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers.

1.4 COORDINATION

A. Steel Fabricator/Erector:

1. AISC Quality Certified with 10-years of experience.
2. Personnel for non-destructive testing shall have NDT Certification.
3. Minimum Quality Assurance Procedures:

    a. Visually inspect material.
    b. Materials and products being furnished by Fabricator/Erector shall be received and identified in fabrication plant in such manner that materials or products can be identified as being represented by mill test reports or manufacturer’s certificates. Identification marks of materials shall remain on structural steel members through fabrication and erection.
    c. Inspect materials for compliance to ASTM A6, prior to fabrication.
    d. Inspect installation of slip-critical High Strength Bolts and proper bolt tension, as follows:

1) When direct tension indicator method is used, observe installation of bolts to determine that bolt manufacturer's procedure is properly used and determine that correct indication of tension has been achieved.
2) Visually inspect to confirm that plies of connected elements have been brought into firm contact.
3) Visually inspect welds as specified in AWS Code, Section 6.
4) Product Manufacturer/Supplier of structural items shall inspect and test products as specified in designated ASTM Specifications; reference Submittals, this Section.

B. Adjustments necessary in steel frame because of fabrication, construction or erection discrepancies in elevations and alignment shall be responsibility of Contractor.

C. Structural Steel Material for Curtain Wall Assembly:

1. Metal Surfaces, General: For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and applying surface finishes.
2. Structural Steel: Shapes, bars, plates, structural pipe, bolts, washers, or other connecting hardware as indicated on Structural Construction Drawings according to appropriate ASTM standards determined by system design.

D. Survey Work:

1. Contractor shall employ at his expense registered professional engineer or surveyor to establish control points and layout work for Building Control Lines. Steel framing subcontractor shall conduct layout work and elevations for erection of structural steel.
2. Check elevations of concrete and masonry bearing surfaces and anchor bolt locations prior to erection and submit discrepancies to Project Director/COR prior to start of erection. Corrections or adjustments to structural steel shall be made and submitted for approval prior to start of erection.

E. Contractor alone is responsible for correct fitting of structural members and for elevation and alignment of finished steel structure. Contractor is responsible for establishing, setting, and maintaining control points and building lines to be used in plumbing structural steel frame in accordance with AISC Code of Standard Practice, Section 7.11, and shall verify the following:

1. That anchor bolts are located as identified on Construction Drawings and are in proper relation to control points and building lines, prior to setting of structural steel.
2. That structural steel members have been located, elevated, plumbed, and aligned in relation to control points and building lines, within tolerance permitted by AISC Code of Standard Practice, Sec. 7.11. Any adjustments necessary in steel frame because of fabrication, construction or erection discrepancies in elevations and alignment is responsibility of Contractor.

F. Upon completion of erection of steel frame and before start of work by other trades that are supported, attached or applied to frame, General Contractor shall make final survey of frame and submit report certifying compliance with specified tolerances.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver each assembly to project site with fabrication, finishing, and assembly of primary panels, embeds/sub-frames, and frames completed and prepared for installation and connection with security systems. Store products in manufacturer's unopened packaging until ready for installation. Store in dry, well-ventilated and covered areas at temperatures below 27 degrees C (80 degrees F).

B. Pack laminated glazing assemblies and accessories; One crate for laminated glazing on enclosed pallet, and one crate for all framing components, anchors, bolts, screws, shims, ballistic trim, shop drawings, and similar items. Provide separate compartment in each crate for each type of component. Removable covers/trim shall be shipped separately.

C. Provide protection of pre-finished units or laminated glazing, such as pre-finished with baked enamel or stainless steel, using self-adhesive paper.

D. Treat laminated glazing assemblies as fragile merchandise, and packaged and shipped in export wood cases with width end in upright position and blocked together in a mass. Comply with Manufacturer's directions for storage and handling to prevent edge damage or other damage to assembly resulting from effects of moisture, condensation, temperature changes, direct exposure to sun, and contact with chemical solvents. Clearly mark crates to indicate which side should be opened first.

E. Handle laminated panels carefully to prevent damage; do not drop, slide, or drag.

F. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

G. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration. If bolts and nuts become dry or rusty, clean and re-lubricate before use with lubricants that are compatible with laminated-glazing.

H. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

I. Store materials, other than fabricated steel, in weather tight containers until ready for use in work. Store containers in dry place.

J. Store electrodes in rod ovens and heat in accordance with AWS Code, Section 4.5 prior to use in welding.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace curtain wall components that fail in materials or workmanship within specified warranty period for non-conformance with manufacturer's performance specifications. Failures include, but are not limited to, the following:

1. Failure to meet performance requirements.
2. Deterioration of metals, other materials, and metal finishes beyond normal weathering.
3. Delamination of glazing layup, protective coating failure, loss of light transmission, and yellowing.

B. Warranty Period: 5-years from substantial completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General:

1. System Description: Exterior wall assembly of custom grade transparent polycarbonate or custom grade glass-clad polycarbonate laminate affixed to custom designed structural frame, with frame attached structurally at each floor level of building structure.

a. Mullions: Provide mullions between window units that are designed to produce thermal isolation and performance equal to performance of adjacent window unit frames. Mullions must conform to FE/BR and blast requirements identified in this Section.

2. Delegated Design: Design of curtain wall system, with associated structural frame, steel structure, including comprehensive engineering analysis by qualified professional engineer, using performance requirements and design criteria identified in this Section.
3. British Standards: References to British Standards do not preclude the use of comparable United States standards.

B. Climb Resistance: Conform to the climb-resistance requirements and criteria in the OBO Building Code.

C. Structural Performance:

1. Blast Resistance: Curtain wall system shall produce resistance to blast; see Section 080001 "Blast Requirements."

a. Curtain wall system framing may include, with approval of Project Director/COR, structural elements which will dampen lateral forces transmitted to protected structure both in positive and negative phases of blast event.

2. Wind Load: Curtain wall system shall withstand the effects of wind loads determined as follows, with no permanent deformation or breakage within curtain wall system when tested according to ASTM E 330.

   a. Basic Wind Speed: Refer to OBO-ICS IBC Chapter 16 for speeds in area this project is located.

D. Air Infiltration for Curtain Walls: Not more than 0.015 L/s per m (0.010 cfm/ft.) of crack length at inward test pressure of 75 Pa (1.56 lbf/sq. ft.) when tested according to ASTM E 283.

E. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing when tested according to ASTM E 331 at minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 480 Pa (10 lbf/sq. ft.).

F. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 480 Pa (10 lbf/sq. ft.).

   1. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

G. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:

   1. Temperature Change (Range): 67 deg C (120 deg F), ambient; 100 deg C (180 deg F), material surfaces.
   2. Test Interior Ambient-Air Temperature: 24 deg C (75 deg F).
   3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

H. Energy Performance: Aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.

   1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 1.5 W/sq. m x K (0.40 Btu/sq. ft. x h x deg F) as determined according to NFRC 100.
   2. Solar Heat Gain Coefficient: In general, fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.44 as determined according to NFRC 200. Refer to Section 088855 “Security Glazing” for limitations of solar heat gain coefficient at certain locations.
   3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 65 as determined according to NFRC 500.

I. Sound Transmission: Provide aluminum windows with fixed glazing and framing areas having the following sound-transmission characteristics:

J. Outdoor-Indoor Transmission Class: Minimum 34 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

K. [Structural performance criteria for "Air Infiltration for Curtain Walls", Water-Penetration under Static Pressure", "Water Penetration under Dynamic Pressure", and "Energy Requirements" may not be required in retrofit applications where the existing building envelope (protected by exterior security curtain wall system conforming to these performance parameters and is not compromised by the retrofit.]

2.2 MANUFACTURER/FABRICATOR

A. Laminated Glazing and Frames: Provide components, including laminated glazing and frames, which conform to one of the following:

2.3 COMPONENTS

A. Laminated Panels Glazing: Design, materials, construction and finish specified is minimum acceptable standard of quality.

1. Comply with Section 088855 "Security Glazing."

B. General Glazing Accessories:

1. Glazing Accessories: As recommended by manufacturer of plastic glazing sheet for wet or dry glazing installations.

2. Sealants: In accordance with Division 07 Section on joint sealants.

C. Metals – General:

1. Metal Surfaces: Provide materials with smooth, flat surfaces without blemishes.

D. Aluminum Extrusions:

1. General:

a. Aluminum shall have chemical composition and temper appropriate for its function, exposure and applied finish.
b. Use Grade 6061 T5 of BS EN 12020 for exposed anodized aluminum extrusions.
c. Use Grade 6061, 6063 or 6106 of temper class T5 or T6 of BS EN 12020 for other locations.
d. Extrusions shall have webs, walls, and flanges of sufficient thickness and eliminate distortion of elements in finished Works.
e. Structural design of aluminum extrusions shall comply with BS 8118 or AS 1664.
f. Comply with BS EN 486, BS EN 573-3, BS EN 755 AND BS 1161.
g. Minimum wall thickness in structural parts to be 2.5mm (1/10 inch).
h. Minimum wall thickness for extruded mullion caps shall be 2.4 mm.

i. Minimum wall thickness for covers, trims and other visible elements shall be of a gauge capable of retaining flatness and consistency with no oil-canning or other distortion when subjected to the design wind pressures required for the project, but not less than .9 mm thick for continuous snap on trim.
j. Platforms, webs, flanges, races and screw flutes shall be of sufficient size to satisfy all structural requirements and eliminate distortion to finished surfaces.
k. Steel reinforcing sections incorporated within aluminum extrusions to provide additional stiffness or strength shall be hot-dip galvanized, and conform to BS5950.
l. Connections shall be consistent with assumed structural engineering assumptions. Reinforcement can be considered to act compositely or as load sharing.
m. Dissimilar metals shall be separated by approved isolator to prevent corrosion due to galvanic action. Isolation is required for connections.

2. Sheet, strip and plate:

a. Alloys shall comply with BS EN 485-3.
b. Hidden Flashings: Not less than 1.6mm (63/1000 inch) thick.
c. Components Exposed to View or Impact: Not less than 3mm (118/1000 inch).
d. Chemical composition and temper shall be suitable for application and anticipated exposure and loading.

3. Finish of Aluminum:

a. Coat aluminum extrusions, pressings and similar items prior to assembly.
b. Finish, including color and gloss level, shall be as identified in Construction Drawings and in accordance with Section 099602 “High-Performance FE/BR Coatings.”

E. Weather and Air Seals:

1. Performance Requirements:

a. Sealants used as weather seal and structural glazing must not degrade and or fail under all design conditions including thermal movement, wind load, UV exposure, and seasonal weathering. Sealants and primers shall be compatible with polycarbonate (PC) and thermoplastic polyurethane (TPU). Sealants shall be capable of withstanding movements up to limits identified by manufacturer. Exposed sealant surface shall not crack or bubble. Sealants and primers shall not stain adjacent materials.
b. Select and install in accordance with BS 6213. Sealants shall be compatible, and fit for their intended purpose.
c. Design sealant geometry (and cross section) to accommodate the anticipated substrate movement. Use in accordance with manufacturer’s instructions, particularly relating to use of primers.

2. Weather Seals:

   a. Coordination: Design of seals and selection of glazing materials (e.g., backing rod, glazing tapes) shall be reviewed and accepted by both sealant and laminated glazing suppliers.
   b. Performance Characteristics of Weather Seals:
      1) Low modulus – E less than 0.4Mpa (58 psi) at 100 percent elongation.
      2) Elongation Capacity: +/- 50 percent.
      3) Seals between glass units and steel framing shall be as recommended by curtain wall manufacturer for use with laminated glazing type. Selection shall be based on proposed glazing and curing procedures, as well as compatibility with laminated glazing panels.
      4) Backing rod to be 25 percent wider than joint width
      5) Primers and joint preparation materials as recommended by sealant manufacturer.
      6) Color selection of any visibly exposed sealants as identified in Construction Drawings, or if not, as selected by Project Director/COR.
      7) Acrylic sealants are not acceptable for frame seals or smoke flashings.
      8) Acid curing sealants are not acceptable.

3. Frame and Small Joint Sealant:

   a. Sealants for all other locations, unless otherwise specified, shall conform to ASTM C920 class 25 specifications; see Division 07 Section on joint sealants.
   b. Sealants used between aluminum frame elements:
      1) Compatible with aluminum surfaces and finishes.
      2) Able to accommodate predicted frame movements and distortions of at least 25 percent.
      3) Color selection of any visibly exposed sealants as identified in the Construction Drawings, or if not, as selected by Project Director/COR.

4. Gaskets and Spacer:

   a. Gaskets shall be extruded EPDM complying with provisions of BS-4255-1, or cellular profiled rubber to ASTM-C509.
   b. Inner gaskets of drained and ventilated or pressure equalized sky lighting systems must be formed in a complete frame with scaled joints. Vulcanized rubber gaskets to have factory molded corner joints.
   c. Gaskets shall be resistant to oxidation, ozone and UV degradation.
   d. Gaskets in contact with silicone sealants shall be of heat curved silicone rubber, chemically compatible with silicone sealant, and suitable for specific purpose intended.
   e. Gaskets, weather seals, and spacers shall have continuous mechanical attachment to framing members. Adhesive attachment is not acceptable.
   f. Sponge gaskets, weather seals, and spacers shall to be extruded black neoprene or silicone rubber, and shall conform to ASTM C509 for neoprene products.

5. Separating and Isolating Materials: Separating material shall be compatible with any material with which it comes into contact and isolating material should be non-conducting, non-compressible, and non-water absorbing

F. Fasteners:

1. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls.

   a. Stainless-steel fasteners for fastening aluminum.
   b. Stainless-steel fasteners for fastening stainless steel.
   c. Stainless-steel fasteners for fastening nickel silver.
   d. Bronze fasteners for fastening bronze.

2. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed; these shall be hot-dip galvanized in accordance with ASTM F 2329.

3. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

   a. Material for Interior Locations: Carbon-steel components zinc plated conforming to ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) or Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

4. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 41 by 22 mm (1-5/8 by 7/8 inches) by length indicated with anchor straps or studs not less than 75 mm (3 inches) long at not more than 200 mm (8 inches) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, as needed for fastening to inserts; these shall be zinc-plated conforming to comply ASTM B 633, Class Fe/Zn 5.

G. Miscellaneous Materials:

1. Concrete: Comply with requirements in Section 033000, "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 20 MPa (3000 psi).

2.4 FABRICATION

A. General:

1. Fabricate curtain wall system in accordance with manufacturer's instructions and accepted shop drawings.

2. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

3. Fabricate seams and other connections that will be exposed to weather in manner to exclude water. Incorporate weep holes where water may accumulate.

B. Curtain Wall Window System:

1. Multi-frame units (unitized construction) or single frame windows shall be complete window units assembled in the factory with windows glazed in the factory.

2.5 FINISHES

A. See Section 099602 "High-Performance FE/BR Coatings."

PART 3 - EXECUTION

3.1 INSTALLATION, PREPARATION

A. Securely place templates to preclude misplacements of anchor bolts, and install bolts at locations and with projections established by accepted structural steel shop drawings.

B. General Contractor and Structural Erection Subcontractor shall separately check and agree upon correct positioning before concrete is placed.

C. Subsequent displacement of anchor bolts is responsibility of Contractor.

3.2 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Cladding and Trim tolerances: Cladding profiles and fastening shall be designed to remain in place. Maintain hairline joint alignment without deformation under positive and negative wind loads indicated in the drawings.

1. Maximum misalignment of two adjoining members abutting in plane: 70 mm,

D. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended.

E. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

F. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.3 FIELD QUALITY CONTROL FOR THE GENERAL CONTRACTOR/INSTALLATION CONTRACTOR:

A. Inspection: The manufacturer's technical representative shall observe and advise the crew during their installation of the first three FE/BR windows. Upon completion of the installation of each of the three initial FE/BR windows, the manufacturer's technical representative shall inspect the work and direct the crew in any correction or modifications required for acceptable performance of the units.

B. For unique site and design conditions, such as sloped glazing or atrium windows, the manufacturer's technical representative shall also be responsible for observing and inspecting the installation of FE/BR windows, beyond the initial three windows, as necessary to ensure that the installation crew is adequately prepared for installation.

C. Water Leakage Testing:

1. Representative windows shall be field tested for water leakage in accordance with ASTM E1105 (Procedure A):

2. Initial testing shall be performed on each window type shown on the window schedule immediately following approval of the trial installation. Subsequent tests shall be carried out

at 30 percent and 60 percent completion of each system. Static pressure differential shall be as specified in the Part 2 Article on PERFORMANCE REQUIREMENTS.

3. At least [three] <insert number> initially successful tests shall be performed on each window type.

4. Test areas shall include perimeter seals to adjacent construction.

5. Test area locations will be designated by the Project Director/COR.

6. An initially successful test shall be defined as one wherein no leakage is observed. If leakage occurs at any point in the test area, the test shall be immediately declared "not initially successful."

7. For each failure condition discovered, make corrective repairs approved by the Project Director/COR and retest until the leakage is eliminated. All failures shall be considered systemic failures requiring corrective work at all similar conditions. Remedial measures shall maintain standards of aesthetics, quality, and durability, and are subject to approval by the Project Director/COR.

8. For each "not initially successful" test, test an additional [two] location(s) until an initially successful test is achieved. Additional tests required as a result of initially non-successful tests shall be performed at no cost to the Owner

9. Engage an Independent Testing Agency to perform the tests. Approval of all test areas, test procedures, remediation measures, and test results rests with the Project Director/COR.

D. Sealant Adhesion Testing:

1. Test sealant according to recommendations in ASTM C1521, Destructive Procedure, Method A.

2. Test a minimum of [four] locations on each façade.

3. Repair locations damaged by testing.

4. Where Project Director/COR determines that sealant has failed adhesively from testing or does not comply with requirements, additional testing shall be performed to determine extent of non-conforming sealant. Neatly cut out and remove non-conforming sealant, prepare and prime surfaces, and install new sealant. Perform field adhesion tests on new sealant.

Additional testing and replacement of non-conforming sealant shall be at Contractor's expense.

5. Document testing with photographs and record result

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. After covering laminated glazing, paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

C. Re-glazing of laminated panels: Re-glaze damaged laminated glazing units in accordance with direction of Project Director/COR.

END OF SECTION 084414

Certificate of Compliance

Framed Security Curtain Wall Assembly
Curtain Wall Assembly Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

DESCRIPTION – TRAINING & OTHER DUTIES OF TECHNICAL REPRESENTATIVE

1	The manufacturer's technical representative was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing curtain wall assemblies has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.	**Representatives Name/Date:**

	DESCRIPTION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	Employees performing the installation meet the specified training and experience qualifications.		
3	Each sub-frame has been installed level, plumb and square.		
4	All sub-frame assemblies must have been factory welded together.		
5	All temporary bolts have been replaced with permanent bolts.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
6	All frame bolts and threaded openings in subframe have been cleaned of all oil and debris. All frame bolts have been torqued to manufacturer's specifications. Shims have been inserted all bolt locations.		
7	All product bolts, screws and anchors are metric products		
8	No finish materials overlap the window frame/sub-frame shim space and ballistic trim bars unless the finish materials can be easily removed and reinstalled. Any overlapping finish work (i.e., metal, wood, stone, etc.) must be capable of removal without damaging the window and finish.		
9	Any removable trim covers that cover window glazing stops (angles or tubes) is attached to the frames with screws or clips for easy removal.		
10	Any removable trim covers that cover the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cladding for each window won't be installed until after the final QA inspection has been conducted by the OBO/CFSM/SM/SCD/SEB representative.		
11	The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers.		

DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
Installer Team Lead: Printed Name: _____ Signature: _____ Initials: _____	**Contractor's QC Manager:** Printed Name: _____ Signature: _____ Initials: _____	

Noted Variances:

_____

_____

_____

_____

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DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

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_____

_____

_____

_____

[1] [2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

SECTION 085651 – ALUMINUM SECURITY WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of exterior aluminum window units required to provide specified resistances is indicated on Contract Drawings by elevations/details/schedules/notations.

1. Principal work of this Section can be summarized to include, but not necessarily by way of limitation, aluminum window units in exterior walls of building occurring within 5 meters above grade or accessible platform and blast windows at any location.

B. The descriptions of window units required as work of this Section include custom grade architectural or heavy commercial, fixed (non-operating) extruded aluminum frame type units, except as otherwise indicated.

C. Work of this Section includes all materials, labor, equipment, and services necessary to design, engineer, test, fabricate, deliver, install, and warranty the security windows. These security windows shall provide an airtight and watertight enclosure, complete in every respect, notwithstanding any omissions or inadequacies of Drawings and/or Specifications.

1. This Section includes a continuous and uninterrupted exterior weatherseal, interior airseal, and a pressure-equalized drainage system.
2. This Section includes connections to adjacent construction.

D. [Definitions and Roles for Projects Utilizing the GPE Program:

1. Government Procured Equipment (GPE) Program: A program of the Overseas Buildings Operations (OBO) in which OBO procures security doors and windows in advance of and for the use of upcoming projects. All GPE windows and doors shall be designed and engineered prior to award of the project to the Contractor.
2. Fabricator: This entity is the fabricator/manufacturer of Aluminum Security windows.
3. Manufacturer: This entity is the manufacturer/fabricator of Aluminum Security windows.
4. Contractor: The Contractor is responsible for the design incorporation, delivery and installation of the GPE products. The Contractor is also responsible for the design and construction of the overall facility, as well as the installation of the GPE items selected by the Contractor in conformance with the overall requirements of the project. The Contractor is responsible for development of a GPE product list and submission of the list to the government for approval, with the design development drawings.]

E. Related Sections include the following:

1. Division 01 Section "Secure Shipment."
2. Section 033000 “Cast-In-Place Concrete”; for movements and tolerances of concrete building structure elements.
3. **[Division 05 Section “Structural Steel”; for movements and tolerances of steel building structure elements.]**
4. Division 07 Section(s) on “Flashing and Sheet Metal.”
5. Division 07 Section “Joint Sealants and Caulking.”
6. Section 080001 “Blast Requirements.”
7. Section 083454 “FE/BR Door Assemblies.”
8. **[Section 084414 “Structurally-Framed Security Curtain Wall System”]**
9. Section 085652 “Aluminum Security Teller Windows”
10. Division 08 Section on general glazing requirements.
11. Section 088855 “Security Glazing.”
12. Section 099602 “High Performance FE/BR Coatings”
13. Other sections of these specifications for interface of door hardware and device units, with alarm/security/safety/access/monitoring systems.

14. **[Division 01 Section on Building Enclosure (FE/BR Windows and Doors) Commissioning.]**

15. **[Division 08 Section “GPE Window and Door Requirements.”]**

1.2 PRE-INSTALLATION MEETINGS

A. Before beginning installation of the FE/BR assemblies, the manufacturer's technical representative shall conduct a pre-installation conference at the Project site with the installation sub-contractor, the electrical sub-contractor, the Project Director/COR, and other interested parties to review installation procedures and manuals, schedules, and coordination of the FE/BR-assembly installation with other elements of the Work.

1.3 REGULATIONS AND STANDARDS

A. Standards and codes referenced in this Specification shall be those editions, including amendments, current at the date of this Specification.

B. In the event of a conflict between referenced codes and standards and/or the Drawings and Specifications, the code or standard having the more stringent requirements shall govern.

C. Comply with the following industry Standards, unless more stringent requirements are indicated or are required by an approved product manufacturer, use metric versions of the standards if available:

1. American Institute of Steel Construction (AISC): 303 “Code of Standard Practice for Steel Buildings and Bridges,” 341 “Seismic Provisions for Structural Steel Buildings,” and 360 “Specification for Structural Steel Buildings.”
2. American Iron and Steel Institute (AISI): Steel designations.
3. American Welding Society (AWS): D1.1 “Structural Welding Code - Steel,” D1.2 “Structural Welding Code - Aluminum,” D1.3 “Structural Welding Code - Sheet Steel,” D1.6 “Structural Welding Code - Stainless Steel.”
4. Aluminum Association (AA): “Aluminum Design Manual,” and “Aluminum Standards and Data.”
5. American Society for Testing and Materials (ASTM): Documents specified herein.
6. American National Standards Institute (ANSI): Documents specified herein.
7. American Architectural Manufacturers Association (AAMA): Documents specified herein.
8. Building Hardware Manufacturers Association (BHMA): Hardware finish designations.
9. Consumer Products Safety Commission (CPSC): Documents specified herein.
10. Glass Association of North America (GANA): “Glazing Manual,” “Laminated Glazing Reference Manual,” and “Tempering Division Engineering Standards Manual.”
11. National Association of Architectural Metal Manufacturers (NAAMM): “Metal Finishes Manual.”
12. Research Council on Structural Connections (RCSC): “Specification for Structural Joints Using High-Strength Bolts.”
13. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): “Architectural Sheet Metal Manual.”
14. Steel Structures Painting Council (SSPC): “Steel Structures Painting Manual, Vols. 1 & 2.”

1.4 ACTION SUBMITTALS

A. General:

1. All submissions must be in accordance with Division 01 Specifications.
2. Submit shop drawings, samples, data, reports, and engineering calculations for the Project Director/COR 's approval before proceeding with the Work of this Section. Upon award of contract, provide a submittal log which indicates submittal packages and sequence, as well as a list of major products proposed to be furnished. Submissions shall be made according to a schedule that allows adequate time for review and approval by the Project Director/COR as stated in the General Conditions.
3. Submissions shall be complete and comprehensive and include all shop drawings, samples, material data submissions, and engineering calculations for the part of the window addressed. All work shall be coordinated by the Contractor prior to submission. Incomplete, non-conforming, or uncoordinated submissions shall be subject to rejection or return without action by the Project Director/COR. Any work executed which deviates from the approved shop drawings and submittals shall be subject to rejection.

B. Product data for manufactured fabricated aluminum window units. Include information for metals and alloys, fasteners, welding, applied finishes, hardware, and accessories. Include producer's detailed instructions for assembly, protection, installation, and maintenance. Note any

maintenance information that may adversely affect the glazing according to section 088855 “Security Glazing.”

1. Manufacturer’s standard color chart.

C. Shop drawings:

1. All shop drawings showing blast resistant window assemblies shall be signed and stamped by window vendor’s blast consultant. All sheets shall be of one size and shall bear the seal of an engineer licensed in the appropriate jurisdiction.
2. Show dimensioned detail of aluminum window units and adjacent construction.
3. Show application of intended glazing materials.
4. Show typical window unit interior and exterior elevations at not less than 1:20 scale.
5. Submit shop drawings in PDF format. After final modifications and corrections have been incorporated, submit drawings as AutoCAD files with .DWG extension as well as in PDF format.
6. Cover sheet: Include manufacturer's name, address, telephone, and facsimile numbers; customer and address; project location; contract or purchase order number; and submittal release record.
7. Unit Information:

    a. Manufacturer's model number
    b. Government certification number.
    c. 4-Digit DOS Code.
    d. Mark (window no.).
    e. Window/frame finish.
    f. Window type.
    g. Performance ratings.
    h. Structural wind loading.
    i. Air infiltration.
    j. Water penetration rating.
    k. Thermal movements.
    l. Energy performance.
    m. Sound transmission.
    n. Fire rating.
    o. Glazing panel weights.

8. Elevation Drawings:

    a. Rough opening dimensions.
    b. Frame opening dimensions.
    c. Vision opening dimensions.
    d. Substrate/rough opening material.
    e. Manufacturer's name and reference numbers for primer and finish paint, including number of coats applied and thickness of each coat in accordance with Section 099602 “High-Performance FE/BR Coatings.”
    f. Separate steel sub-frames (number and list).
    g. Detail symbols.

h. Glazing panel dimensions.

9. Plan Drawings:

a. Relate to elevation on drawing.
b. Identify "Attack" and "Protected" sides.
c. Provide key notes on drawings.
d. Indicate room space numbers taken from Contract Drawings.

10. Details:

a. Clearly illustrate all aspects of the windows including:

1) The relationship of the windows to the building structure, roofing and waterproofing systems, interior finishes, and other adjacent construction.
2) The arrangement of components.
3) Full size details indicating: sealing, flashing, weeping, and jointing; all dimensions and thicknesses; materials and finishes; material, type, size, location, and spacing of screws, bolts, welds, anchoring devices, and glazing accessories; locations of conduit entry into both subframe and window frame (where applicable).
4) Steel frames and subframes including plan and section details and corner conditions.
5) Details shall include all components, fully coordinated and integrated, regardless of the component provider.
6) Include sizes and strength of anchor, fasteners and washers.
7) Window and frame gauge thickness.
8) Covers (snap-on or mechanically attached) thickness and profiles.
9) Electrical access, where applicable.
10) Torque (nm) for anchor bolts.

b. Include details of all connections and seals to contiguous work as approved by the Subcontractor for the work adjacent and include all assumptions regarding the tolerances of that work.
c. Details shall be on separate sheets from plan and elevation drawings.

11. General Product Information: Include notes sheet, miscellaneous materials specifications, abbreviations, glazing layup sheet, finish/paint system, legend, and glazing specifications.
12. Breakdown of Product Line Items:

a. If Manufacturer produces one contract line item as several parts, they shall break out items on drawings. Each item shall be a subdivision of that product line item number. Indicate manufacturer's part numbers for all components.

D. Engineering Calculations:

1. Submit project-specific engineering calculations as described in the Part 2 Article on PERFORMANCE REQUIREMENTS.
2. Submit engineering calculations concurrently with corresponding shop drawings.

3. Insert appropriate location.
4. Calculations shall bear the seal of a Professional Engineer licensed in the appropriate jurisdiction.

E. Blast Report: See Section 080001 "Blast Requirements."

F. LEED Submittal:

1. Product Data for Credit MRc2: Environmental Product Declarations
2. Product Data for Credit MRc3: Recycled Content
3. Product Data for Credit MRc4: Health Product Declarations
4. Product Data for Credit IEQc2, Low Emitting Materials: For glazing sealants used inside of the weatherproofing system, including certificate of VOC emissions and content.

G. Samples for Verification: For windows and components required, prepared on Samples of size indicated below. Submit samples to Project Director/COR at project site.

1. Submit samples of all materials and finishes, including:

a. Samples matching the appearance, color, texture, and other characteristics of each finish required; Samples may be of a standard extrusion with similar properties and will be reviewed visually by the Project Director/COR for color and texture/sheen.
b. Range samples showing the complete range of variation in color, texture, and other characteristics resulting from the carefully controlled manufacture, finishing, fabricating, delivery, assembly, installation and cleaning processes;
c. Finished samples of major extrusions;
d. Finished samples of each sheet in thickness and type required;
e. Samples showing finishes over welds and over materials welded.

2. Submit four identical pieces of each sample required.
3. The Manufacturer and Contractor shall provide samples of production materials shall be provided by the following sizes:

a. Fastening devices: Each type.
b. Finish hardware: Each type.
c. Finish samples: 30 cm x 30 cm, each type and finish.
d. Finished extrusions: 30 cm in length.
e. Finished sheet: 30 cm x 30 cm, each type.
f. Flashing: 30 cm long, each type. Include lap or splice jointing.
g. Glass: 30 cm x 30 cm, each type and edge finish.
h. For insulating glass units provide assemblies representative of units to be used in the finished work, including scheduled glass, coatings, spacers, edge seals, and edge deletion.
i. Sealants: Cured sample, 30 cm long, each type.

4. [Window Corner Fabrication: Provide one 300-by-300-mm (12-by-12-inch) sample for record to OBO. Sample shall include a full-size sections of extrusions with factory-applied color finish, cladding and removable covers, weatherstripping, and glazing. If directed by OBO, when a current sample is available at OBO headquarters, an additional sample is not required.]

H. Condensation Resistance Simulations:

1. Submit computer simulation results confirming conformance with specified condensation resistance performance criteria.

1.5 INFORMATIONAL SUBMITTALS

A. Installer Qualifications:

1. For FE/BR/Blast installations, submit crew leader resumes documenting the lead installers have installed FE/BR/blast assemblies for a DOS project within the last 5 years.
2. Submit list of installer's personnel who have received the manufacturer's training according to the requirements in the Part 1 Article on QUALITY ASSURANCE.

B. Copy of DOS Certification Letter: Copy of DOS Certification letter indicating that products have been certified by the Bureau of Diplomatic Security (DS) in accordance with DS/PSP/PSD SD-STD-01.01, Rev H.

C. Certificates of Compliance:

1. Completed certificates of compliance documenting that all FE/BR assemblies have been installed per the contract documents. Complete and submit to the Project Director/COR the form referenced in the Part 1 Article on QUALITY ASSURANCE. Certificate of Compliance form is found at end of this Section.

D. [Energy Performance Certificates: NFRC certified energy performance values for each glazed wall system.]

E. Test Reports:

1. General: Submit test reports in a timely manner and well before execution of any related component of the windows.
2. Submit laboratory test reports, showing compliance with performances required for air infiltration and water penetration.

F. Installation Instructions:

1. Provide standard window installation and glazing panel replacement instructions and customized supplement for each type of application that varies from the standard window

installations. Installation manual and supplement shall be approved by the OBO/CFSM/SM/SOD/PSO/FE/BR Program Section.

2. Manual shall be customized for each type of application.
3. Manual shall identify in the installation steps where "products by others" such as flashing and finishes surrounding the product are to inface/take place. Installations steps for "products by others" is not required.
4. Develop instructions for unique conditions as they are identified.
5. Manual shall include step-by-step instructions for installing FE/BR doors with supporting photos, illustrations and figures that also includes sections for General Requirements, List of Tools & Expendable Supplies, Window Removal from Crate, and Cleaning.
6. Manufacturer's Technical Representative shall submit list of unique project specific site conditions that require special manufacturer representative inspection and/or installation training.

G. Quality Control Program: Submit prior to start of fabrication. See Part 1 Article on QUALITY ASSURANCE.

1.6 CLOSEOUT SUBMITTALS

A. Special Warranty: Provide special warranty in accordance with the Part 1 Article on WARRANTY.

B. Maintenance Manuals:

1. At the completion of the Project, **[submit four bound copies of][digitally submit]** a maintenance manual for all window components. Include instructions for cleaning, repair, and maintenance of the work, including re-glazing procedures within the manual or as a separate manual. Include warranties, manufacturer's data and contact information for all components.

C. Installation and Maintenance Instructions: At the completion of the project, digitally submit a maintenance manual for all security glazing components. Include the following information:

1. Glazing replacement instruction or manual which includes step-by-step instructions with photographs and illustrations for all window conditions on the project and includes the following information:

a. List of tools and expendable supplies.
b. Removal of the damaged glazing.
c. Cleaning the window frame.
d. Removal of the replacement glazing from the crate.
e. Transporting the glazing on a heavy-duty glass cart from the loading dock to window location.
f. Positioning the new replacement setting blocks and any glazing tape or foam on the frame and/or glazing pocket as appropriate.
g. Lifting the glazing from the cart with a glazing robot into the window frame
h. Installing the glazing stops.

i. Inserting any gaskets or applying any sealant as appropriate.
j. Best practices recommendations for glazing replacement:
k. Removal of the replacement glazing from the crate.
l. Transporting the glazing on a heavy-duty glass cart from the loading dock to window location.

2. Instructions for cleaning.
3. Copies of Warranties.
4. Copies of Manufacturer's product data.
5. Contact information for manufacturers and suppliers of all components.

D. Record Shop Drawings: At the completion of the Project, **[submit four bound sets of half-size prints of] [digitally submit]** all final approved shop drawings.

1.7 QUALITY ASSURANCE

A. Testing Laboratory Qualifications: For compliance with non-security performance requirements on security window assemblies of this Section, use only those testing laboratories which have successfully demonstrated to Project Director/COR that they have experience and capabilities needed to satisfactorily conduct required tests.

B. Delegated Design Responsibility: Contractor shall retain an experienced Professional Engineer, registered in the U.S. or in country with significant experience with windows of similar complex performance requirements, and acceptable to the Project Director/COR, to perform responsibilities of Delegated Design.

C. Quality Control for Forced-Entry/Ballistic Resistant (FE/BR) Products: Certify compliance of fabricated and assembled FE/BR products specified in this Section with each quality control procedure established by the Government; these procedures are identified in Compliance Form found at end of this Section. Other quality control forms are found at end of Section 083454 "Forced Entry (FE) / Ballistic Resistant (BR) Door Assemblies."

D. Installer Qualification Data: The installer's qualifications must be approved by the Office of Overseas Buildings Operations, Construction Facilities Security Management, Security Management, Security Countermeasures Division, Security Engineering Branch (OBO/CFSM/SM/SCD/SEB). Submit resumes of all team lead installer (present and responsible for each install), documenting that installer has installed FE/BR window assemblies for DOS projects with last five years. Resume shall include at least three references (including contract information) that can provide verification that the installer has expertise required to perform successful installation. Each installer or installation team must be certified by the manufacturer as being capable of properly installing the FE/BR products. The installer must provide written documentation to the Project Director/COR that the installation team is certified in the manufacturer's product installation.

E. Manufacturer's Technical Representative: **[The manufacturer shall appoint a manufacturer's technical representative to the project.] [For GPE projects the contractor will hire from the**

manufacturer a technical representative.] The manufacturer's technical representative shall be an employee of the manufacturer and have the following responsibilities:

1. Pre-Installation Conference: See Part 1 Article on PRE-INSTALLATION MEETINGS for the representative's responsibilities.
2. Training: The manufacturer's technical representative (at no cost to the U.S. Government) shall provide the crew, which is to actually perform the installations of the FE/BR assemblies with a minimum of 16 hours of on-site, hands-on training which shall include the complete installation of at least three FE/BR windows, with the exception of the snap on trim, and training on glazing replacement and completion of the Certificate of Completion for each of the three windows. The manufacturer's technical representative shall also instruct the crew on preventive measures which must be taken to protect the FE/BR assemblies from damage during construction.
3. Inspection: See Part 3 Article on FIELD QUALITY CONTROL FOR THE GENERAL CONTRACTOR/INSTALLATION CONTRACTOR for the representative's responsibilities.
4. Additional Assistance to the Government: The manufacturer's technical representative (at no cost to the U.S. Government) shall provide the Contractor any additional advice, instruction, training, supervision, or inspection required to enable the Contractor to complete the installation certification described below, and to fully train the Embassy staff in the proper operation and maintenance of the FE/BR assemblies while on site before turn over to the DOS.

F. Certification by General Contractor: Prior to final completion, the General Contractor shall provide to the Project Director/COR a certification that the FE/BR materials have been installed in accordance with the manufacturer's instructions, these specifications and are operational. Sample Certificates of Compliance are attached to the end of this specification. Deviation from these requirements is only permitted with the written approval of OBO/CFSM/SM/SCD/SEB or OBO/CFCM/SM/SOD/PSO/FE/BR. The General Contractor shall provide certification that the requirements in these specifications have been included in the work. The following requirements are part of this Certification.

1. The manufacturer's technical representative was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing security windows has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.
2. Employees performing the installation meet the specified training and experience qualifications.
3. Each sub-frame has been installed level, plumb and square.
4. All sub-frame assemblies shall be factory welded together. Any large sections that exceed the limits of a standard shipping container shall be clearly identified for field welds.
5. All units have been pre-glazed at the factory.
6. All temporary fasteners have been replaced with permanent fasteners.
7. All frame fasteners and threaded openings in subframe have been cleaned of all oil and debris, and have been dry-torqued to meet the manufacturer's specifications. Shims have been inserted at all bolt locations, minimum 1 shim per bolt and maximum as tested condition.
8. Frame bolts/screws are as shown on the approved shop drawings.

9. Finish materials do not overlap the window frame/sub-frame or shim space and ballistic trim bars in such a way that the window cannot be re-glazed unless the surrounding finishes and trim are demolished; unless the finish materials can be easily removed and reinstalled. All overlapping finish work (e.g., metal, wood, stone) can be removed without damaging the window and finish.
10. Any cladding that covers window glazing stops (angles or tubes) is attached to the frames with hidden fasteners or snap on covers for easy removal.
11. Any cladding that covers the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cap plugs and cladding for each window have been bagged and won't be installed until after the final QA inspection has been conducted by the OBO/CFSM/SMSCD/SEB representative.
12. Separate pieces of ballistic trim have been installed, as indicated in the approved shop drawings.
13. Ballistic trim bars have been secured/screwed to the sub-frame and not the window frame.
14. Ballistic trim bars have been installed tight against the window frame, or sill flashing, and gap shall not exceed 2 mm or as tested by the manufacturer.
15. Maximum gap at shim space shall be no more than then the tested and DS certified assembly, except as noted in the requirements for “Window Flashings” within the Part 3 Article on INSTALLATION.
16. The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers (see Part 1 Article on IDENTIFICATION SYSTEMS below).

G. Quality Control inspection documents shall incorporate:

1. Security Glazing Requirements including the following:

   a. Whether internal channels are used to separate glass from polycarbonate or otherwise framed for solid laminated glazing, minimum glazing depth in openings (bite) for attack and protected sides which shall not be less than 20 mm and 6 mm cushion clearance to fixed stop on glazing edges.

H. Quality Control Program:

1. Quality Control Program shall cover all phases of the window Work including, but not necessarily limited to, the following:

   a. Procurement of materials, including quality assurance programs of major suppliers.
   b. Fabrication of components.
   c. Production testing.
   d. Final assembly of components.
   e. Installation and site quality control.

2. Quality Control Program shall indicate the following for each quality control measure/activity:

   a. Item/property being inspected/tested
   b. Control point in process and frequency of inspection/testing
   c. Inspection/test method

d. Acceptance criteria and reference standards/specifications
e. Method of documentation
f. Action to address deficiencies

3. Quality Control Program shall include detailed descriptions of inspection and production testing programs and inspection reports for:

   a. Coatings of metal. Coordinate and include controls by metal fabricator and finisher, as well as by Contractor to provide independent checks of metal quality and finish at point of fabrication, finishing, and during installation
   b. Structural glazing.

4. At the request of the Project Director/COR, a Government representative shall be allowed access to Contractor's facilities and those of major suppliers at with advance notice to monitor QC procedures. Make available all QC Program records upon request.

1.8 TESTING AND MOCK-UPS

A. [NFRC Testing:

1. Provide, install, and test specimens of the vision-glazed window systems at an NFRC-accredited laboratory as necessary to obtain NFRC certification and labeling.
2. The Contractor or their designee shall be the "Responsible Party" as defined in the NFRC procedures.
3. Obtain certification and "NFRC Label Certificates" prior to installation.]

B. Trial Installations:

1. Refer to the crew training responsibilities in the requirements for "Manufacturer's Technical Representative" in the Part 1 Article on QUALITY ASSURANCE.
2. Prior to general installation of windows, erect on the building a representative trial installation of each window type for the Project Director/COR's approval.
3. Propose the scope and location of trial installations for the Project Director/COR's approval.
4. Notify the Project Director/COR well in advance of each such trial installation. If approved, this portion of the work shall become part of the final installation.
5. Provide a demonstration at the job site where the windows will be installed simulating replacement of a glazing panel at different floor levels using technology (,e.g., roof mounted davit & winch systems from the exterior or glazing robot from the interior along with two workers on each side, exterior and interior, accessing the window head, jambs and sill).

C. Pre-Construction Sealant Testing:

1. Test proposed field applied sealants for adhesion and compatibility with each type and color of substrate or material coming into contact with them.

2. Test proposed sealants for staining of each type and color of porous substrate or material coming into contact with them, including other sealants.
3. Test specimens shall be of the size required by the manufacturer's testing laboratory and shall be composed of the specified materials, colors and finishes.
4. Adhesion testing: ASTM C794.
5. Compatibility testing: ASTM C1087.
6. Stain testing: ASTM C1248.
7. Tests shall be performed by the sealant manufacturer whose products are being considered.

D. Structural Silicone Testing:

1. Test silicone joints proposed for structural glazing for performance in tension, shear, and tension and shear combined, in accordance with ASTM C1135.
2. Test specimens: approximately 5 cm in length, full dimension in width and depth, and be composed of the specified materials, colors and finishes.
3. Ten specimens for each condition shall be tested and the values for elongation-to-failure vs stress recorded for each specimen, and the mean and standard deviation calculated for each condition.
4. Tests shall be performed by the structural silicone sealant manufacturer whose products are being considered.
5. In addition to the above, production testing shall be performed at regular intervals during assembly of the window, as specified.

1.9 IDENTIFICATION SYSTEMS

A. Identify each assembly to provide Government with ready reference to original manufacturer to facilitate reorders, replacement parts, service, resolution of complaints, and inventory. Provide a steel stamped ID plate. Locate one plate on the lower right corner (hidden) of the secure side of the window frame. Locate one plate on lower right of the interior window frame snap on trim or cladding (visible). The plate shall be approximately 40 x 75 mm, must be easily accessible and shall cite:

1. Manufacturer's name/city/state.
2. Government certification DOS model number.
3. Contract number.
4. Month/year of manufacture.
5. Mark number.
6. Four digit DOS CODE

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver each assembly to project site with fabrication, finishing, and assembly of primary panels, sub-frames, and frames completed and prepared for installation and connection with security systems. Refer to Division 01 Section "Secure Shipment" for additional requirements.

B. Deliver window assemblies as factory glazed unless otherwise directed by Government.

C. Pack window assemblies and accessories; One crate for the window and frame, including installation accessories: All anchors, bolts, screws, shims, ballistic trim, shop drawings, etc. Provide a separate compartment, and clearly label each crate for each type of component. Removable covers/trim and sub-frames may be shipped separately. Multi-unit elevations may separate the ballistic bolts, ballistic bars and trims which span, or are shared, by several unites into separate crates. With OBO/CFSM/CM approval bulk packaging of like materials, may be approved on a case-by-case basis.

D. Provide protection of frame exposed finishes using surface protection film.

E. Treat security window assemblies as fragile merchandise, and packaged and shipped in export wood crates, not constructed of Oriented Strand Board (OSB), with width end in upright position and blocked together in a mass, except as noted below. Do not use plastic or polyethylene sheeting, or extruded polystyrene. Comply with Manufacturer's directions for storage and handling to prevent edge damage or other damage to assembly resulting from effects of moisture, condensation, temperature changes, direct exposure to sun, and contact with chemical solvents, and ground contaminants. Clearly mark crates to indicate which side should be opened first.

1. If the window is designed to be shipped on the jamb side, to include setting blocks on the jamb side, and label jamb and crate “ALTERNATE SILL” and indicated orientation.

F. Clearly mark sub-frames with window mark number and identify attack side, head, sill, and left and right jambs. Package sub-frames separately and ship in export wood crates separate from the window assemblies. Protect each sub-frame piece to minimize damage to finished surfaces.

G. Conduct thorough visual inspections of the glazing prior to packaging.

H. Include a complete list of non-compatible materials for temporary protection during construction and cleaning.

I. Include tip-and-tell, temperature, and humidity indicators with packaging, one for each crate, located on exterior of the crates and one of each on interior of crates. Manufacturer shall provide one crate label, located next to exterior tip and tell and one fly sheet with the packing material indicating the humidity maximum limits allowed for the glazing.

J. Store materials in a dry, well-ventilated location. Keep handling of materials to a minimum, and carefully protect materials from soiling and from condensation and other harmful moisture. Provide vapor-permeable materials for protection during shipping. Do not trap moisture within or adjacent to windows.

K. Conduct thorough visual inspections of glazing before installation. Inspections should include removal of glazing stops, if applicable. Do not install glazing with any cracks in the polycarbonate. Contractor shall remove film after doors and windows are installed on project site.

1.11 WARRANTY

A. Special Warranty: Written warranty in which Contractor agrees to repair or replace components of the windows that do not comply with requirements or that fail in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Abnormal deterioration, aging and weathering of the windows;
b. Leakage of water or air exceeding specified limits;
c. Structural failure of components resulting from exposure to pressures and forces within specified limits;
d. Failure of operating parts to function normally;
e. Deterioration/discoloration of finishes in excess of normal weathering and aging;
f. Glass breakage due to defective design, manufacture, or installation;
g. Edge separation or any other deterioration whatsoever of laminated glass;
h. Cracking or crazing of polycarbonate glazing;
i. Failure of the windows to meet any other specified performance requirements.
j. Warranty Period: Five years from date of Substantial Completion.

B. Warranty, Organic Coatings: See Section 099602 “High-Performance FE/BR Coatings.”

C. Manufacturer’s Special Warranties for Structural and Weatherseal Sealants:

1. Written warranties in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that fail to provide airtight and watertight joints, or fail in adhesion, cohesion, abrasion resistance, stain resistance, weather resistance, or general durability or appear to deteriorate in any other manner not clearly specified in the manufacturers data as an inherent quality of the material.
2. Warranty Period: 10 years from date of Substantial Completion
3. Glazing Period: See requirements for special product warranties in Section 88855, “Security Glazing.”

1.12 EXTRA MATERIALS

A. Furnish extra materials identified below. Package extra materials with protective coating for storage and identification labels describing contents.

1. Glazing panels: Two vision and two spandrel units for each module, glazing type and size.
2. Frame retention set screws and other non-perishable parts required for re-glazing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design of the windows (including comprehensive structural analysis) shall be performed by a professional engineer. Refer to the Part 1 Article on QUALITY ASSURANCE for required qualifications. Responsibilities also include design and integration of associated security glazing, and ensuring conformance to performance requirements for security glazing; see Section 088855 "Security Glazing."

1. Applicable Criteria: Utilize criteria identified below, including criteria such as seismic and other loads. Engineering design development, materials and methods of construction other than that indicated or implied by the Contract Documents may be employed when such materials and methods when they are consistent with these criteria. Any deviations from these, or clarification where there are apparent conflicts with these, must be obtained from the Project Director/COR.

a. Performance requirements identified in this Article.
b. Other applicable criteria included within the OBO Design Standards (e.g., OBO Codes, reference documents).
c. Design intent documents prepared by the A/E involved with RFP documentation, and consistent with these performance requirements and other criteria in the OBO Design Standards.

2. Contractor's Professional Engineer's Responsibilities:

a. The Contractor's Professional Engineer shall prepare and endorse complete engineering design and calculations and shall check and monitor the preparation of all shop drawings for conformance with the engineering design and calculations, and for compliance with the Contract Documents.
b. Engineer shall submit structural calculations for all components of the windows and indicate ultimate factors of safety.
c. As evidence of conformance to these requirements, each shop drawing and calculation sheet shall bear the seal and self-written signature of the Engineer.

B. General: Fabricate and install aluminum framed window units anchored to steel subframes to achieve the following security-related resistances, along with other indicated performances. Extend resistance to include anchorages and interfaces with adjoining substrates. Provide window rating as listed on the window schedule.

1. Forced-Entry (FE) resistance rating for attack with ordinary hand tools for the following ratings of the Physical Security Division of the Bureau of Diplomatic Security (DS/PSP/PSD).

a. Government Code 1: No FE resistance rating.
b. Government Code 2: 15 minutes.
c. Government Code 3: 60 minutes.
d. Government Code 4: 5 minutes.

2. Ballistic Resistance (BR) assemblies: Where window assembly is shown or scheduled as BR, provide the following ratings:

   a. Government Code 1: No BR resistance rating.
   b. Government Code 2: Submachine gun, 9 mm.
   c. Government Code 3: Rifle, 5.56 & 7.62 NATO.
   d. Government Code 4: Armor piercing, 0.30-06.

TABLE 2.1 - WINDOW CODES

DOS CODE	1ST DIGIT – WINDOW COMPOSITION	2ND DIGIT FIRE RATING	3RD DIGIT – FORCED-ENTRY RATING	4TH DIGIT – BALLISTIC RESISTANCE RATING
1	Transparent	None	None	None
2	Opaque	1.5 hours (Class D at exterior)	15 minutes	Not Used
3	Not Used	3 hours (Class A)	60 minutes	Rifle 5.56 & 7.62 NATO
4	Not Used	45 minutes (Class C)	5 minutes	Armor-Piercing (.30-06)

3. Provide combined performances for indicated requirements, with each performance surviving combined attacks within rating limitations of performance, but recognizing that certain forms of attack may result in severe damage to units, even though repelled successfully, leading to need for replacement of units, or of damaged elements of units.

C. Blast Resistance: See Section 080001 “Blast Requirements.”

D. Ballistics-Resistance Performance: Provide units identical to those tested for compliance with the following requirements:

1. Certified as complying with SD-STD-01.01, Revision H, by the U.S. State Department, for ballistics resistance when tested by a qualified testing agency.

E. Forced-Entry-Resistance Performance: Provide units identical to those tested for compliance with the following requirements:

1. Certified as complying with SD-STD-01.01, Revision H, by the U.S. State Department, for forced-entry resistance when tested by a qualified testing agency.
2. If blast, or other requirements, result in changes to the tested FE/BR design, to include anchor or other material changes, the FE/BR vendor shall contact DS/PSP/PSD/RD to determine if a technical review is required.

   a. Shop drawings should include the TR model number, where applicable.

F. Climb Resistance: Conform to the climb-resistance requirements and criteria in the OBO Building Code.

G. Structural Performance: Aluminum security windows shall withstand the effects of wind loads determined as follows, with no permanent deformation or breakage within window assembly when designed in according to ASCE 7-16, as adopted and amended by the OBO Building Code, and tested according to ASTM E 330:

1. Basic Wind Speed: Shall be as indicated in the Structural Drawings.

H. Structural Glazing Sealant Bite: Sealant bite shall be adequate to resist specified loads.

I. Snap-on Components: Concentrated load of 4.5 kg (10 lbs.) at any point.

J. Air Infiltration for Fixed Windows: Not more than 0.2 L/s per sq. m (0.04 cfm/sq. ft.) at an inward test pressure of 300 Pa (6.27 lbf/sq. ft.) when tested according to ASTM E 283.

K. Water Penetration:

1. Under Static Pressure: No evidence of water penetration through fixed glazing when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 480 Pa (10 lbf/sq. ft.).
2. Under Dynamic Pressure: No evidence of water penetration through fixed glazing when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 480 Pa (10 lbf/sq. ft.).
3. Maximum Water Leakage: Water penetration shall be defined as any water, other than condensation, that appears on any interior surface of the window, or on any surface inside the concealed spaces of the window or adjacent construction not designed specifically to function as part of the rainwater management system for the building enclosure. This definition of water penetration governs over those found in referenced documents.

L. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:

1. Temperature Change (Range): **[67 deg C (120 deg F)], ambient; [100 deg C (180 deg F)]**, material surfaces **<Edit for local conditions>**.
2. Test Interior Ambient-Air Temperature: 24 deg C (75 deg F).
3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

M. Energy Performance: **[Aluminum security windows shall have certified and labeled energy performance ratings in accordance with NFRC.]**

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than **[1.5]** W/sq. m x K (**[0.40]** Btu/sq. ft. x h x deg F) as determined according to NFRC 100.
2. Solar Heat Gain Coefficient (SHGC): Refer to Section 088855 "Security Glazing" for limitations on performance requirements for certain glazed assemblies.
3. In general, fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than **[0.47]** as determined according to NFRC 200, or as identified in the specified glazing type in the 088855 Security Glazing Specification.

    a. Fixed glazing and framing in locations where special coatings using approved coating products are used, a solar heat gain coefficient of no great than **[0.XX] [as determined according to NFRC 200]**.

4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than **[55]** as determined according to NFRC 500.

N. Visible Light Transmittance (VLT): Refer to Section 088855 "Security Glazing" for limitations on performance requirements for certain glazed assemblies.

O. Sound Transmission: Provide aluminum windows with fixed glazing and framing areas having the following sound-transmission characteristics:

1. Outdoor-Indoor Transmission Class (OITC): Minimum 35 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

P. Facilitation of Glazing Replacement: Install aluminum security window assemblies only into a steel substrate in such a manner that allows for future glazing panel replacement. This may be either a structural steel wall or other structural steel assembly, a steel sub-frame in concrete, or a steel sub-frame attached to concrete**[or masonry]**.

Q. Mullions: Provide mullions between window units that are designed to provide thermal isolation and performance equal to the performance of the adjacent window unit frames. Mullions must meet all applicable FE/BR and/or blast requirements.

R. Building Structure Movements and Tolerances:

1. The windows shall accommodate differential structural movements, deflections, interstory drift, and thermal movement of the building structure due to gravity loads, wind loads, seismic loads and temperature.
2. The windows shall accommodate the following without distress, disengagement, or damage:

    a. Slab or Perimeter beam deflection due to service live load, column shortening, and differential long term creep.
    b. Interstory lateral drift (serviceability).

3. The windows shall accommodate the following without detachment of components from the building or glass fallout:

a. Inter-story lateral drift (ultimate).

4. The windows, including its connections to the building structure, shall accommodate the fabrication and erection tolerances allowed for the building structure.

a. Slabs, beams, and columns; left/right and up/down.

5. It is the responsibility of the Contractor to refer to the appropriate specifications of Cast-In-Place Concrete, Structural Steel, or Metal Framing for the full description of structural movements and tolerances.

S. Animal Nuisance Control:

1. The windows shall inhibit the entry of insects or other small animals which would constitute a nuisance by their presence.

T. [Fire Safety:

1. Provide fire-resistance rated assemblies, as indicated in Contract Documents, and as required to conform to OBO Codes (OBO-adopted model codes as amended by OBO Code Supplements).]

2.2 MANUFACTURER/FABRICATOR

A. Selection of fabricator/manufacturer for each type of security window assembly, and selection of manufactured elements which are used in make-up of that assembly, are Contractor's options subject to the following requirements and limitations, approval by the Project Director/COR and subject to general provisions of Construction Contract:

1. Pre-certified fabricators of ballistic--resistant and forced-entry-resistant assemblies are identified in a separate Contract attachment labeled “Government Certified FE/BR Products and Designs".

2.3 METALS

A. Select the alloy, degree of alloy control, homogeneity, temper, metallurgical quality, degree of hardness or softness, mill tolerances, cutting tolerances and flatness, required to achieve the requirements of design, quality, and color matching of finish set forth in Drawings and Specifications.

B. Aluminum:

1. Flat sheet: AA [**3003 for painted finish] [5005 for anodized finish]** H14, ASTM B209, stretcher-leveled and stress-relieved.
2. Extrusions: AA 6061-T6 or AA 6063-T5 or T6; ASTM B221.
3. Other flat sheets and extrusion grades and selection may be allowed with the approval of OBO/CFSM/SM/SCD/SEB, but in all cases, they should not only meet the physical requirements, but ability to finish the material shall be similar.

    a. Extruded aluminum cladding for mullion caps shall be minimum 2.4 mm thick.
    b. Cladding for other exterior applications shall be of a gauge capable of retaining flatness and consistency with no oil-canning or other distortion when subjected to the design wind pressures required for the project, but not less than 1.2 mm thick.

C. Carbon Steel:

1. Rolled shapes, plates and bars: ASTM A36, A572, A992.
2. Hollow steel sections (HSS): ASTM A500
3. Cold rolled sheet and strip: ASTM A1008.
4. Hot rolled sheet and strip: ASTM A1011.
5. Fasteners:

    a. Bolts and Screws: ASTM A307 or F3125 Grade A325 or A490.
    b. Socket Head Cap Screws: M12, Zinc-plated.

        1) For non-blast rated windows: Class 10.9 (Grade 8) or Class 12.9.
        2) For blast rated windows: As required by blast analysis report; see Section 080001 “Blast Requirements.”

    c. Washers: Zinc-plated.

        1) For non-blast rated windows: Class 10.9 (Grade 8) or Class 12.9.
        2) For blast rated windows: As required by blast analysis report; see Section 080001 “Blast Requirements.”

    d. Nuts: ASTM A563 or ISO 4032/8673.

D. Stainless Steel:

1. Sheet, plate, bars and strip: ASTM A240, sulfur not to exceed 0.005 percent; ASTM A480, stretcher-leveled and stress-relieved.

    a. Exposed: AISI Type 316
    b. Concealed: AISI Type 304

2. Fasteners: AISI Type 303, 304 or 316 (exterior).

    a. Bolts and screws: ASTM F593.
    b. Nuts: ASTM F594.
    c. Button and countersunk head screws: ASTM F879.

2.4 FABRICATION AND ASSEMBLY

A. General:

1. To the fullest extent practicable, all fabrication and most assembly shall be executed in the shop. Work not shop-assembled shall be shop-fitted to ensure fit. Refer to Part 3 Article on INSTALLATION; any remaining assembly work is part of that activity.
2. Use no materials, equipment or practices that may adversely affect the function, appearance, performance, or long-term durability of the completed windows or adjacent construction.
3. The windows shall be accomplished in compliance with the specified criteria without buckling, opening of joints, undue stress on fasteners, sealants and gaskets, opening of welds, cracking of glass, leakage, noises or other harmful effects.
4. Conform strictly to the materials, finishes, shapes, profiles, sizes, thicknesses, and joint locations required by the Drawings and Specifications.
5. Match all materials to produce continuity of line, texture and color.
6. Work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All work shall be accomplished to the satisfaction of the Project Director/COR.
7. All components exposed in the finished work shall be free from warping, oil-canning effects; the telegraphing of welds, studs, and other fasteners; streaks, tool and die marks.
8. Finish exposed metal edges to match adjacent finished surfaces.

B. Reduce exposure to non-compatible chemical substances including, but not limited to, the following:

1. Phenols.
2. Silicone-based sealants (non-neutral cure agents).
3. Cutting oils.
4. Common cleaning chemicals known to contribute to polycarbonate environmental stress cracking such as ammonia.
5. Isopropyl not allowed unless rinsed with water.
6. Ethylene-propylene rubber (EPDM) setting block and gasket off-gassing compounds.

C. Manufacturer’s Standards:

1. Materials, components and systems incorporated in the Work shall be mixed, applied, installed and otherwise used in strict accordance with the recommended standards and procedures of the respective manufacturers.

D. Storage and Handling at Manufacturing and Fabricating Facilities:

1. Refer to Part 1 Article on DELIVERY, STORAGE, AND HANDLING. Those requirements also apply during the fabrication portion of this Section.

E. Jointing and Reinforcing:

1. Accurately fit and firmly secure all exposed metal joints with metal to metal hairline contacts.

2. Install fastenings at an approved spacing.
3. Fasteners shall not penetrate gutters and drainage systems.
4. Screws and fasteners up to and including 8 mm (5/16 inch) diameter and all that are drilled and/or tapped into aluminum shall be 300 series stainless steel.
5. Fasteners 9.5 mm (3/8 inch) diameter and heavier shall be stainless steel or hot-dip galvanized.
6. Jointing and splicing of members shall be concealed. Exposed fasteners shall occur only where expressly permitted by the Project Director/COR. Where exposed in finished surfaces, screw heads shall be Phillips oval-head countersunk type, finish to match adjacent surfaces.
7. Conceal all joint sealants except as noted on the Drawings.

F. Anchors and Connections:

1. Reinforce elements to resist loads imposed upon them by doors, hardware, anchors, and other attachments. The window manufacturer shall provide anchors appropriate for substrate to which window frame and sub-frame is to be fastened.
2. Anchors and connections shall be provided to fully satisfy their required purpose of adjustability, movement and load transfer.
3. Design connections between different materials shall allow for the differential thermal movement of the respective materials.
4. Anchors and connections that do not provide for movement shall prevent such movement by appropriate means.
5. Anchors and connections that are designed for movement shall be of such construction that friction is low enough to allow for such movement without buckling and other damage and without causing binding and noises.
6. Self-drilling, self-threading fasteners shall not be permitted for use into concrete or masonry for the window frame, but is allowed for ballistic trim.
7. Separate metal surfaces shall be designed such that metal does not move on metal. Materials used for this purpose shall be low friction components, sealants or gaskets as applicable.
8. Anchorages to Structural Steel shall not induce rotational forces in supporting members.
9. All anchors and fasteners outboard of the air-seal shall be 300 series stainless steel. All other fasteners shall be stainless steel or zinc-plated steel. Fastener and anchor assemblies shall be detailed to prevent galvanic corrosion.
10. Shim packs that resist compressive forces only may be solid high-impact plastic, Korolath type or equal. Shim packs subject to bending or shear forces shall be stainless steel or HDG steel plates pinned together to form a monolithic shim.
11. Window frames shall have pre-drilled, vertically slotted bolt hole patterns at the jambs and left/right slotted bolt hole patterns at the head and sill, not to exceed as tested on center spacing.
12. The manufacturer shall verify substrates involved, and supply any special fastening tools (e.g., special drill or bit) required by anchoring system.
13. The anchor shall be acceptable for shock/short duration loading, and have potential for removal and re-installation during life of building.

G. Welding:

1. Weld steel in accordance with the recommendations of the American Welding Society.
2. Welding shall be done by skilled mechanics qualified by test in the last 12 months as prescribed in the American Welding Society Code and as applicable to the material thickness and type of welded joint on which the welders will be employed.
3. Welding shall be done with electrodes and/or methods recommended by the suppliers of the metals being welded. The type, size, and spacing of welds shall be as shown on the approved shop drawings. Welding materials and methods shall be such as not to cause distortion, discoloration, or result in any other adverse effect on the required profiles and finishes of visible surfaces of the windows.
4. Welding of aluminum alloys and the qualifications of aluminum welders shall conform to the requirements of the Aluminum Association "Specifications for Structures of Aluminum Alloys, Aluminum Construction Manual".
5. Welding of stainless steel shall be by TIG welding or other methods subject to approval. Use double bevel butt welds, backing bars to remove heat, jigging, tack welds and any other measures necessary to minimize distortion.
6. Remove weld spatter and welding oxides on exposed surfaces. Finish exposed welds to match and blend with adjacent parent metal prior to final finish application.
7. Stud welding shall be done by mechanics trained by the manufacturer of the stud setting system. The manufacturer shall develop specific programs and instructions in cooperation with the fabricator to suit the needs of the specific details. The fabricator shall exercise particular care that all recommendations of the manufacturer are closely followed. Visible marks (telegraphing) on finished surfaces due to welding of studs shall not be acceptable.

H. Sealant and Gasket Applications:

1. Provide sealing mechanisms (sealants and gaskets) where shown on the drawings or required for a permanently weathertight installation. The sealing mechanism for each location and use shall be as indicated on drawings. In those locations where a mechanism is necessary but is not indicated, it shall be of a type recommended by the Contractor and approved by the Project Director/COR.
2. Design all sealed joints in accordance with the recommendations of the sealant and/or gasket manufacturer.
3. Gasket materials shall be appropriate for the function intended and are subject to approval by the Project Director/COR.
4. Submit test samples of all substrate materials to the sealant manufacturer for compatibility and peel adhesion testing.
5. Protect adjoining surfaces not to receive sealants against staining by masking and/or other methods. Conceal sealant joints from view to the extent possible. Do not allow sealants to contact interlayers of laminated glass.
6. Joints and joint surfaces shall be clean, dry, and free of any materials that may have an adverse effect on the performance of the sealant and gasket materials.
7. Sealant application: ASTM C1193.
8. Apply sealants and gaskets under the climatic conditions recommended by the manufacturer(s). Sealant shall not be installed when substrates are wet or when ambient or surface temperature is below 40 deg F. All surfaces to receive sealants shall be treated (cleaned, primed or unprimed) in accordance with the recommendations of the sealant manufacturer. Use no sealant that has started to set in its container or a sealant that has exceeded the shelf life published by the manufacturer.

9. Glazing gaskets shall be vulcanized, injection molded or heat-welded at the corners to form a continuous closure.
10. Fill all joints continuously and completely with sealant, forming a neat uniform, concave bead. Finish the material flush with adjoining surface unless otherwise shown on the Drawings. All sealant surfaces shall be tooled smooth. Upon completion of tooling, immediately remove masking tape from adjacent surfaces.

I. Glass and Glazing:

1. Comply with the GANA "Glazing Manual."
2. Glazing shall be performed without springing or forcing. Follow all instructions of the glass and glazing materials manufacturers.
3. Glass and glazing materials shall be compatible with each other and adequate for their intended purpose. Each material type shall be as per details and approved Shop Drawings.
4. Protect all adjoining surfaces not to receive glazing materials against staining or damage of any kind.
5. Glazing pockets shall be clean, dry, and free of any materials that might adversely affect the bond and seal of the glazing materials or the drainage of the pockets.
6. Install glass and glazing materials under the climatological conditions recommended by the fabricator.
7. Prime all surfaces to receive glazing materials unless recommended otherwise, in writing, by the manufacturers and approved by the Project Director/COR.
8. Use no sealant that has started to set in its container, nor a sealant that has exceeded the shelf life published by the manufacturer.
9. Do not install sealant unless the ambient and joint surface temperature is at least 40°F and rising.
10. Install exposed sealants so that the top surfaces of the sealant beads are sloped to drain water away from the glass. Exposed sealant surfaces shall be tooled smooth.
11. Setting blocks shall be at least 6 mm (1/4 inch) in thickness, full width of the pocket, and placed at the glass quarter points. They shall be of a length recommended by the glass manufacturer and be configured in such a way as not to impede water drainage of the glazing pocket.
12. Provide jamb blocks on each glass unit supported on four sides. Place and glue blocks at the top and bottom of the glazing pocket 3 mm (1/8 inch) clear of the glass edge.
13. Glass shall be centered in each opening to provide the bite and clearances recommended by the glass manufacturer and approved by the Project Director/COR.
14. Apply no tapes, ribbons or markings to the glass.

J. Structural Glazing:

1. Comply with ASTM C 1401.
2. Wherever possible, silicone glazing design shall permit glazing to the major framing members in the factory.
3. Provide test samples of all substrate materials to the sealant manufacturer for peel adhesion and accelerated weathering testing. Conduct testing with materials and finishes identical in every respect to approved production materials and finishes.
4. Prior to undertaking any structural glazing, submit complete structural glazing procedures, including permissible conditions, temperatures, cure times, temporary restraint design,

surface preparation and all other procedures, including quality control inspection program that may be employed.

5. Perform periodic deglazing of structural silicone glazed lites per ASTM C1401 Paragraph 34.4 and the sealant manufacturer's recommendations, at a rate of one unit in the first 10 produced, one in the next 40, one in the next 50, and one every 100 thereafter.
6. Clearance and bite dimensions shall match approved shop drawings.

K. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

1. Provide thermal-break construction that has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.

L. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior for dry glazed units:

M. Mullions with Strong-backs or Steel Connections: Provide thermally improved mullions and cover plates matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

N. Sub-Frames: Provide steel sub-frames/embeds for all FE or FE/BR windows for installation at concrete, masonry, and other non-steel rough openings and for structural steel openings where depth is less than door frame depth. Steel subframe material shall conform to ASTM A36 or ASTM A529 or ASTM A572 for plates, bars, and shapes; and ASTM A500 or ASTM A1085 for hollow structural sections ("steel tubes"). No steel element to receive a threaded fastener shall be less than 12 mm (1/2 inch) thick. For individual openings, sub-frames shall be provided by window supplier. For larger, multi-panel openings, sub-frames may be provided by either window supplier or Contractor; in either case they shall be designed by window supplier and shown with window shop drawings. For larger elevations that require knock-down subframe, provide hot-dipped embeds. Sub-frame depths shall be no less than the window frame depth on side of sub-frame that window is bolted. Steel sub-frame shall be assembled and braced by manufacturer prior to shipping to ensure deformations during transportation. Ensure steel sub-frame is braced so that deformation tolerances are not exceeded during installation and concrete placement. Where sub-frames are hot-dipped galvanized, temporary supports shall be designed and detailed not to damage to the galvanized surfaces during use and removal. Steel sub-frame shall be installed plumb and square. All sub-frames without adjustability shall be drilled and tapped in the field.

1. Exterior sub-frames/embeds and shall be hot-dipped galvanized for corrosion resistance.
2. Interior sub-frames/embeds shall be prime painted with a high-grade metal primer or may be hot dipped galvanized.

O. Post-installed Anchors: In addition to any restrictions or requirements indicated on the Construction Drawings, post-installed anchor systems proposed by the Contractor's delegated design shall each have ICC-ES Evaluation Report indicating conformance with current applicable ICC-ES Acceptance Criteria including, but not limited to, for cracked concrete for concrete substrates, seismic applications, and for the use in the specific substrate type and characteristics intended. Shop drawings and field sketches shall clearly indicate critical embedment, spacing, and edge distance requirements and placement tolerances determined by the design.

1. For New Concrete Substrates: Attach steel sub-frame to the concrete substrate with embedded anchors per the blast report, but not less than 12 mm diameter x 150 mm headed steel studs, spaced no greater than 300 mm on center. Final sub-frame shop drawings, product data, and associated delegated design calculations shall be reviewed and approved prior to fabrication and shipment.
2. **[For Masonry Substrates: Provide steel sub-frame, typically a plate, tube, or channel that has a minimum 12-mm thickness for the anchors and a minimum 300 mm width and as determined per the blast design, when blast is a requirement. Post-installed chemical anchors in hollow masonry substrates shall use appropriate screen tubes provided by the anchor system's manufacturer.]**
3. **[For Existing Concrete Substrates: Provide steel sub-frame, typically a plate, tube, or channel that has a minimum 12-mm thickness for the anchors and a minimum depth of the product and as determined per the blast design, when blast is a requirement and in all cases should take into account the existing reinforcing blast.]**

P. [Window replacement and retrofit conditions: When FE/BR window is being replaced in kind, existing embed or subframe may be used if visually assessed to be in good condition and determined by calculation to possess sufficient capacity to meet the specified performance requirements for the window system. It does not need to be replaced solely because it does not meet one of above 12 mm thickness requirements for new sub-frames. Sub-frame design shall provide accommodations for field adjustments to enable installation when verifications in the field prior to fabrication for reinforcing steel or other elements are limited or not feasible. Filling abandoned holes in steel elements with weld material to tap a new hole overlapping the prior hole is not permitted; drilling and tapping a larger diameter hole fully encompassing the smaller hole is permitted, such as in a scenario where the existing threads are damaged or determined to be inadequate for the new connection design. New anchor holes shall satisfy minimum AISC 360 requirements for bolt hole spacing and edge distances. If subframe does require replacement, as determined by OBO/SM, or due to other conditions (e.g., corrosion or size of opening requires modification), then one of new subframe conditions above must be used.]

Q. Factory-Glazed Fabrication: Glaze aluminum windows in the factory. Comply with requirements in Section 088855 "Security Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.

R. Glazing Stops: Provide snap-on or bolted glazing stops coordinated with Section 088855 "Glazing" and glazing system indicated. Provide glazing stops to match frames.

S. Cladding: Cladding shall include any extruded, break metal or otherwise formed component or trim that is applied as a decorative or finish covering of the window frame, mullion, steel frame, trim bars or other components integral to the functional security glazing system.

1. Exterior cladding material: shall be aluminum, stainless steel, or pre-approved composite compatible with the functional security window system.
2. Interior metal cladding or trim: Interior metal cladding shall be aluminum, stainless steel, or pre-approved composite compatible with the functional security window system.
3. Cladding or trim of any type that overlaps security window frame, sub-frame, shim space or ballistic trim bars shall be installed such that the window can be re-glazed without damage to any component or finish of the window system or to the Trim or cladding component, when trim is reinstalled.
4. If overlapping material must be removed to re-glaze a window, the material fastening system shall be designed to allow for easy removal and reinstallation without damage to the original overlapping material.

2.5 PROTECTIVE TREATMENT FOR METALS

A. Galvanizing Carbon Steel (hot dip):

1. For shapes, plates, bars and strip: ASTM A123 (2 oz/ft2 minimum coating thickness).
2. For fasteners and hardware: ASTM A153.
3. For sheet: ASTM A653 (G90).
4. For protection against hydrogen embrittlement: ASTM A143.
5. For repair of damage to HDG coatings: ASTM A780.

   a. Acceptable product: ZRC Cold Galvanizing Compound, ZRC Worldwide.

B. Bituminous Paint: SSPC-Paint 12 or ASTM D1187, 762 microns (30 mils) minimum thickness.

C. Surface Protection Film:

1. Colored, strippable PVC film specifically intended for the temporary protection of metal.
2. Film thickness: 76.2 microns (3 mils) minimum

2.6 ALUMINUM FINISHES

A. Coat aluminum extrusions, pressings and similar items prior to assembly.

B. Finish, including color and gloss level, shall be as identified in Construction Drawings. Except where anodic finishes are identified, refer to Section 099602 “High-Performance FE/BR Coatings”

1. Non-visible components shall be painted per the FE/BR Performance Coating required or may be anodized.

C. [Anodic Finishes:

1. **Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.**
2. **Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.**
3. **Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.]**

D. No mill finish aluminum is permitted on visible and non-visible components.

E. Match the appearance, color and texture of samples submitted to and approved by the Project Director/COR.

2.7 STEEL FINISHES

A. Carbon Steel: For strong-backs and other exposed subframes, connectors, and ballistic trim, and similar applications.

1. Coat carbon steel shapes and similar items prior to assembly to the maximum extent feasible.
2. Finish, including color and gloss level, shall be as identified in Construction Drawings and Section 099602 “High-Performance FE/BR Coatings.
3. All surfaces of steel members incorporated in the windows shall be finished.
4. If concealed from view, individual and aggregate members shall be hot-dip galvanized in accordance with the Part 2 Article on PROTECTIVE TREATMENT FOR METALS.

5. If exposed to view and connected to exterior elements, individual and aggregate steel members shall be hot-dip galvanized and receive the coating systems as indicated in Construction Drawings and specified in Section 099602 “High-Performance FE/BR Coatings.”

B. Stainless Steel:

1. Finish: uniform and free from blemishes, scratches, and other defects.
2. If exposed to view, finish shall be as follows:

   a. [Finish Type SS-1: AISI No. 4 satin directional finish]
   b. [Finish Type SS-2: AISI No. 4 satin non-directional finish]

3. If concealed from view, finish shall be AISI No. 2D.
4. Clean and passivate as per the recommendations of ASTM A 380.

5. The grain of all stainless steel and brushed finishes shall run in the long direction for contiguous or adjacent components except where noted on drawings.
6. Touch-up finish in field as required.

2.8 LOW-FRICTION MATERIALS

A. Wherever materials are subject by design to relative movement, provide suitable low friction material(s), such as:

1. Teflon strip, 0.762 mm (0.030 inch) thick; and Teflon tape, 0.127 mm (0.005 inch) thick.
2. High-impact polystyrene or Nylatron equal to Eel-Slip pads as manufactured by Scan-Pac.

B. Low friction materials shall be impervious to moisture.

2.9 SEALANTS AND SEALANT BACKING MATERIAL

A. Structural Glazing Sealant: The following sealants have been shown to be compatible with laminated glazings that include polycarbonates.

1. Neutral cure silicone, medium or high modulus, non-staining, matte finish, color to match the approved sample, and specifically intended for use specified.
2. Multi-component: ASTM C1184; ASTM C920, Type M, Grade NS, Class 12.5.

   a. Acceptable products:

      1) Dowsil 983, Dow Chemical Co.
      2) GE Ultraglaze 4400 or 4600, Momentive Performance Materials.

3. Single-component: ASTM C1184; ASTM C920, Type S, Grade NS, Class 25.

   a. Acceptable products:

      1) Dowsil 995, Dow Chemical Co.
      2) GE Ultraglaze 4000/4000AC, Momentive Performance Materials.

B. Weatherseal Sealant:

1. Neutral cure silicone, low or medium modulus, non-staining, matte finish, custom color to match the approved sample, and specifically intended for use specified.
2. Single-component: ASTM C920, Type S, Grade NS, Class 50, Use A,G, and O.
3. Acceptable products:

   a. Dowsil 795, Dow Chemical Co.
   b. GE Silpruf SCS2000, Momentive Performance Materials.

C. Sealant Backing Materials:

1. Preformed foam plastics and synthetic rubbers, compressible, non-gassing, non-staining, and compatible with sealants and as recommended by sealant manufacturers. Backing shall be of the sizes and shapes to suit the various conditions and shall be a color different than the sealant color. Backer rods shall be 25 percent wider than the joint width.
2. Open/closed cell extruded polyolefin backer rod: ASTM C1330, Type B.
3. Acceptable product: SOF-ROD, Nomaco Inc.
4. Extruded silicone rubber: As specified in the Part 2 Article on PRE-FORMED SYNTHETICS.
5. Cellular glazing tape: As specified in the Part 2 Article on PRE-FORMED SYNTHETICS.
6. Bond Breaker Tape: Lithographer Tape, 3M Company.

2.10 PRE-FORMED SYNTHETICS

A. The particular compound shall be appropriate to the intended function of the preformed synthetic and is subject to approval by the Project Director/COR.

B. Base gasket material manufacturers and gasket extruders are subject to approval by the Project Director/COR.

C. All material shall be non-staining, non-off-gassing, UV stabilized, ozone-resistant, and compatible with glazing edge sealants and polycarbonate.

D. All corners of weatherstripping shall be vulcanized, heat-welded, injection-molded, or otherwise required to form a continuous seal around the panel.

E. Gaskets:

1. Interior closed cell sponge gaskets: silicone gaskets: ASTM C 509, 60 ±5 Shore A durometer.
2. Exterior non-cellular dense wedge gaskets: Non-cellular silicone gaskets: ASTM C 864, 70 ±5 Shore A durometer.
3. Setting blocks:
4. Non-cellular (dense) extruded silicone: ASTM C 1115 Type C, 85 ±5 Shore A durometer, not less than 6mm thick.
5. Spacers, edge blocks, and other profiles:
6. Non-cellular (dense) extruded silicone: ASTM C 1115, 50 to 70 Shore A durometer.

F. Cellular Glazing Tapes:

1. Open cell, semi-rigid, adhesive-backed foam tape.

   a. Acceptable products: Norton Thermalbond V2100, V2200, or Xpress.

2. Closed cell, semi-rigid, adhesive-backed foam tape.

   a. Acceptable products: Norton Norseal V780 or V980.

G. Thermal isolators:

1. Clamped between metal components:

   a. Rigid polyvinylchloride: ASTM D 4216.

2. Integral to extruded aluminum framing: AAMA TIR-A8.

   a. Continuous extruded polyamide 6/6 (Nylon) with 25% glass fiber reinforcement, mechanically crimped to extrusions with knurled cavities. Comply with AAMA QAG-2-12.

      1) Perform shear tests per QAG-2-12. Shear value: Greater than 200 lb/in.

   b. Polyurethane poured into a cavity of a single extrusion; dibridged after polyurethane hardens. Polyurethane thermal break systems shall utilize the thermal cavity in accordance with the material manufacturer's recommendations.

3. Provide a continuous thermal break with separation distance as required to comply with specified thermal performance requirements.

H. Weep Hole Filter: PVC-coated reticulated open cell polyurethane foam, 30 to 40 pores per 25.mm (1 inch) in length.

I. Shims: Provide compatible shim material for window frames and adjacent enclosure systems using one of the following:

1. Concealed: Solid PVC, polystyrene, or Nylon
2. Exposed to weather: Stainless steel.

2.11 FLASHING MATERIALS:

A. While General Contractor has overall responsibility for installation of all flashing materials, Manufacturer shall coordinate shop drawings and adjust rough opening and dimensions to accommodate specified flashing below:

B. Metal: Min. 0.607 mm (24 ga.) stainless steel, dead-soft.

C. Pre-Formed Silicone Sheet: ASTM C1518, Movement Class 200, Tear Class PT.

1. Dowsil 123 Silicone Seal, Dow Chemical Co.
2. Ultraspan, Momentive Performance Materials

D. Foil-Faced Polyethylene-Reinforced Self-Adhering Flashing (SAF):

1. Perm-A-Barrier Aluminum, Grace Construction Products
2. HE200AM Metal Clad Weather Barrier, Henry Company
3. Aluma-Flash, Polyguard Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine prepared substrate openings to receive framed fenestration units of this Section. Check anchorages for location and coordination of face plans between walls and fenestration units.

B. Prior to start of installation, inspect the building and verify all conditions and dimensions as being acceptable to receive the Work of this Section.

C. Coat substrate surfaces of concrete, masonry, or steel where they will be in contact or close proximity with aluminum or stainless steel framing of fenestration units. Apply membrane and weather proofing, or a minimum to confined to surfaces which will be concealed.

D. If any conditions are found that may inhibit proper execution of the Work, immediately notify the Project Director/COR in writing. Installation shall not proceed until remedial action, acceptable to the Project Director/COR, has been executed.

3.2 INSTALLATION:

A. Sequencing and Timing Requirements: At the time agreed upon with Project Director/COR, proceed with installation of fabricated aluminum window units in accordance with approved shop drawings, manufacturer's data and instructions, requirements of these specifications and attached Certificate of Compliance. Sequence installation work to achieve proper application for each element indicated, in manner which will produce maximum resistance to indicated forms of attack and weather.

B. Complete any assembly that was not accomplished in the shop. Refer to Part 2 Article on FABRICATION AND ASSEMBLY.

C. Erect the windows, including all snap-on components and accessories, plumb, square, level, and correctly aligned within the following limitations:

1. Offset from true horizontal, vertical, and design location shall not exceed 3.2 mm (1/8 inch) per 3.7 meters (12 feet) nor 12 mm (1/2 inch) over any one length or part thereof the building.
2. Offset from true alignment between abutting components or components separated by less than 75 mm (3 inches) shall not exceed 1.6 mm (1/16 inch).
3. Maximum offset of framing members intersecting at the corner of a glazing cavity shall not exceed 0.80 mm (1/32 inch).
4. Rotation shall not exceed one degree.

D. Joint widths as noted in the Contract Documents are the design joint width at an ambient temperature of 21 deg C (70 deg F). Adjust installation procedures to take into account the ambient temperature at the time of installation.

E. Exercise care to properly brace and reinforce units against racking during hoisting and installation.

F. Anchors and Connections:

1. Avoid cutting rebar during concrete sub-frame installation.
2. Provide 1.6 mm (1/16 inch) thick shims with break-off tabs for rough opening (RO) frame clearance.
3. Match finish of cap plugs used in frame with frame finish to the maximum extent possible. Do not install cap plugs until after the final QA inspection has been completed by either the OBO/CFSM/SM/SCD/SEB or OBO/CFSM/SM FE/BR Program representative

G. Metal Cladding Fastening and Connections shall be mechanically fastened with concealed fasteners or snap-on attachment.

1. Exposed fasteners shall not be permitted. Special cladding attachment conditions that cannot be achieved with concealed fasters may be considered only after formal written application for a specification exception, to include documented engineering proof that concealed fasteners are not achievable, and to include finish detailing of the exception condition.
2. Adhesive fastening of window cladding (trim) in absence of mechanical fastening shall not be permitted.
3. Cladding fastening shall allow for easy removal and re-installation after re-glazing, without damage to any part of the security window system or adjacent construction.
4. Cladding and Trim tolerances: Cladding profiles and fastening shall be designed to remain in place and maintain hairline joint alignment without deformation under positive and negative wind loads indicated in the drawings.

a. Maximum misalignment of two adjoining members abutting in plane; 79 mm (1/32”).

H. Window Flashing:

1. Sill flashing: Provide stainless steel flashing bedded over membrane water/vapor barrier installed over steel embed. Note that shims shall be placed over stainless steel flashing; do not damage flashing with shim installation.

a. Sill flashing shall be turned up min. 6 mm (1/4”) on interior side.
b. Bolt penetrations through flashing, and female receptor nuts, shall be filled with non-hardening liquid sealant or water/vapor barrier compatible to flashing and barrier materials.
c. Maximum gap (shim space) between top of stainless steel sill flashing and Window frame shall be 6.5 mm (¼”).

1) The flashing and weather proofing, up to 3 mm, is excluded from calculating the allowable shim space between the embed/subframe and with window frame (i.e. if the flashing and weather proofing combined thickness is equal

to 3 mm and the tested shim space was 6 mm, then the allowable space between the embed/subframe would be 9 mm).

d. Provide weeps in shim space, over stainless steel flashing to allow any water infiltration to drain to the exterior.

2. Jamb and head flashing: Provide liquid or membrane flashing at heads and jambs, providing full cover and protection of steel or concrete window frame/opening. Overlap minimum 4” and seal to top of stainless steel sill flashing to provide continuous flashing around window opening.

I. Corrosion Protection:

1. Ensure by design that no metals, including alloys of the same base metal, are placed together in a manner, combination or location likely to give rise to damage by electrolytic action or other corrosion. Prevent metal to metal contact between aluminum and metals other than an appropriate grade and composition of stainless steel as per the recommendations of the material manufacturer and to the approval of the COR. Ensure that dissimilar aluminum alloys in contact with each other are compatible with each other or isolated. Any other dissimilar materials are to be treated or protected in such a manner as necessary to prevent corrosive action.
2. Isolation of dissimilar metal surfaces to prevent electrolytic action shall be accomplished by materials which are impervious to moisture and non-absorptive.
3. All steel parts shall receive a protective treatment commensurate with their respective functions and locations. The treatment shall be one or more of those described above, and as approved by the COR.
4. Where used to the exterior of air-seals, or in any location vulnerable to moisture, steel shall be hot-dip galvanized after fabrication.
5. Field welds on galvanized steel shall be treated with an approved field cold galvanizing process. Remediation of finish of galvanized steel shall be as per the requirements of ASTM A780 and division 055005.
6. Aluminum surfaces in contact with mortar, concrete, fireproofing, plaster, masonry, or absorptive materials of any kind shall be coated with an anti-galvanic material, impervious to moisture.

3.3 FIELD QUALITY CONTROL FOR THE GENERAL CONTRACTOR/INSTALLATION CONTRACTOR:

A. Inspection: The manufacturer's technical representative shall observe and advise the crew during their installation of the first three FE/BR windows. Upon completion of the installation of each of the three initial FE/BR windows, the manufacturer's technical representative shall inspect the work and direct the crew in any correction or modifications required for acceptable performance of the units.

B. For unique site and design conditions, such as sloped glazing or atrium windows, the manufacturer's technical representative shall also be responsible for observing and inspecting the installation of FE/BR windows, beyond the initial three windows, as necessary to ensure that the installation crew is adequately prepared for installation.

C. Water Leakage Testing:

1. Representative windows shall be field tested for water leakage in accordance with ASTM E1105 (Procedure A):
2. Initial testing shall be performed on each window type shown on the window schedule immediately following approval of the trial installation. Subsequent tests shall be carried out at 30 percent and 60 percent completion of each system. Static pressure differential shall be as specified in the Part 2 Article on PERFORMANCE REQUIREMENTS.
3. At least **[three]** ***<insert number>*** initially successful tests shall be performed on each window type.
4. Test areas shall include perimeter seals to adjacent construction.
5. Test area locations will be designated by the Project Director/COR.
6. An initially successful test shall be defined as one wherein no leakage is observed. If leakage occurs at any point in the test area, the test shall be immediately declared “not initially successful.”
7. For each failure condition discovered, make corrective repairs approved by the Project Director/COR and retest until the leakage is eliminated. All failures shall be considered systemic failures requiring corrective work at all similar conditions. Remedial measures shall maintain standards of aesthetics, quality, and durability, and are subject to approval by the Project Director/COR.
8. For each “not initially successful” test, test an additional **[two]** location(s) until an initially successful test is achieved. Additional tests required as a result of initially non-successful tests shall be performed at no cost to the Owner
9. Engage an Independent Testing Agency to perform the tests. Approval of all test areas, test procedures, remediation measures, and test results rests with the Project Director/COR.

D. Sealant Adhesion Testing:

1. Test sealant according to recommendations in ASTM C1521, Destructive Procedure, Method A.
2. Test a minimum of **[four]** locations on each façade.
3. Repair locations damaged by testing.
4. Where Project Director/COR determines that sealant has failed adhesively from testing or does not comply with requirements, additional testing shall be performed to determine extent of non-conforming sealant. Neatly cut out and remove non-conforming sealant,

prepare and prime surfaces, and install new sealant. Perform field adhesion tests on new sealant. Additional testing and replacement of non-conforming sealant shall be at Contractor's expense.

5. Document testing with photographs and record results.

3.4 PROTECTION, CLEANING, AND ACCEPTANCE:

A. Protect the windows from any material, equipment or practices that may impair the functioning, appearance or durability of the windows or other construction.

B. Package and store materials in a manner that shall prevent damage, contamination, distortion, breakage or structural weakening.

C. Store pre-glazed units upright or crated and packaged with a rigid protection board on top to prevent damage from ponding of water or by the work of other trades.

D. Do not stage units and related components more than one week in advance of installation in order to avoid damage by other trades. Do not uncrate units more than one day in advance of installation.

E. Replace any material damaged during manufacture, shipping, storage or erection.

F. Protect the installed windows from damage by other trades.

G. Protection materials shall be suitable for the intended protection application and protection period. Do not use materials known to contribute to environmental stress cracking of polycarbonate.

H. Install protection materials in a manner that will not trap harmful moisture or otherwise contaminate the Work in any way.

I. Remove and replace any portion of the windows that has been damaged by other trades. Remove rejected or damaged material promptly from the site.

1. Re-glaze all damaged units per manufacturer's instructions. Install manufacturer provided set screws, 4 per window unit prior to removal of the glazing. Set screws shall be standard socket flat point, ISO 4026, DIN 913. After glass is replaced remove set screws and reinstall all permanent frame anchoring bolts in their original positions.

J. Acceptance of the completed installation of the windows requires the installation be sound, watertight and free from defects of materials and workmanship.

K. Immediately prior to completion of the Work, completely clean the entirety of all windows as follows:

1. Clean all components of the Work as per the recommendations of the specific product manufacturer.
2. Clean the windows from the top most levels down in order to avoid staining of cleaned surfaces from cleaning solution residue and run-off.

3. Clean glass with approved glass cleaning solutions only and ensure that cleaning solution is completely removed from the surface after cleaning. Do not clean glass when it is exposed to direct sunlight.

END OF SECTION 085651

Certificate of Compliance

Aluminum Security Window Assemblies
Window Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the FE/BR products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

DESCRIPTION – TRAINING & OTHER DUTIES OF TECHNICAL REPRESENTATIVE

1	The manufacturer's technical representative was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing security windows has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.	**Representatives Name/Date:**

	DESCRIPTION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	Employees performing the installation meet the specified training and experience qualifications.		
3	Each sub-frame has been installed level, plumb and square.		
4	All sub-frame assemblies shall be factory welded together. Any large sections that exceed the limits of a standard shipping container shall be clearly identified for field welds.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
5	All units have been pre-glazed at the factory.		
6	All temporary fasteners have been replaced with permanent fasteners.		
7	All frame fasteners and threaded openings in subframe have been cleaned of all oil and debris, and have been dry-torqued to meet the manufacturer's specifications. Shims have been inserted at all bolt locations, minimum 1 shim per bolt and maximum as tested condition.		
8	Frame bolts/screws are as shown on the approved shop drawings.		
9	Finish materials do not overlap the window frame/sub-frame or shim space and ballistic trim bars in such a way that the window cannot be re-glazed unless the surrounding finishes and trim are demolished; unless the finish materials can be easily removed and reinstalled. All overlapping finish work (i.e. metal, wood, stone, etc.) can be removed without damaging the window and finish.		
10	Any cladding that covers window glazing stops (angles or tubes) is attached to the frames with hidden fasteners or snap on covers for easy removal.		
11	Any cladding that covers the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cap plugs and cladding for each window have been bagged and won't be installed until after the final QA inspection has been conducted by the OBO/CFSM/SMSCD/SEB representative.		
12	Separate pieces of ballistic trim have been installed, as indicated in the approved shop drawings.		
13	Ballistic trim bars have been secured/screwed to the sub-frame and not the window frame		
14	Ballistic trim bars have been installed tight against the window frame, or sill flashing, and gap shall not exceed 2 mm or as tested by the manufacturer.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
15	Maximum gap at shim space shall be no more than then the tested and DS certified assembly, except as noted in the requirements for "Window Flashings" within the Part 3 Article on INSTALLATION.		
16	The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers (see Part 1 Article on IDENTIFICATION SYSTEMS below).		
17	Inspect glazing for distortion, defects and/or damage. Defective units, including spall liner damage, do not meet DS certification requirements and must be replaced.		

Installer Team Lead:	**Contractor's QC Manager:**
Printed Name: _____	Printed Name: _____
Signature: _____	Signature: _____
Initials: _____	Initials: _____

Noted Variances:

_____

_____

_____

_____

_____

_____

_____

DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

_____

_____

_____

_____

_____

[1] [2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

SECTION 085652 – ALUMINUM SECURITY TELLER WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of exterior aluminum window units required to provide specified resistances is indicated on Contract Drawings by elevations/details/schedules/notations.

1. Principal work of this Section can be summarized to include, but not necessarily by way of limitation, aluminum window units in exterior walls of building occurring within 5 meters above grade or accessible platform and blast windows at any location.

B. The descriptions of window units required as work of this Section include custom grade architectural or heavy commercial, fixed (non-operating) extruded aluminum frame type units, except as otherwise indicated.

C. Work of this Section includes all materials, labor, equipment, and services necessary to design, engineer, test, fabricate, deliver, install, and warranty the security windows. These security windows shall provide an airtight and watertight enclosure, complete in every respect, notwithstanding any omissions or inadequacies of Drawings and/or Specifications.

1. This Section includes a continuous and uninterrupted exterior weatherseal, interior airseal, and a pressure-equalized drainage system.
2. This Section includes connections to adjacent construction.

D. [Definitions and Roles for Projects Utilizing the GPE Program:

1. Government Procured Equipment (GPE) Program: A program of the Overseas Buildings Operations (OBO) in which OBO procures security doors and windows in advance of and for the use of upcoming projects. All GPE windows and doors shall be designed and engineered prior to award of the project to the Contractor.
2. Fabricator: This entity is the fabricator/manufacturer of Aluminum Security windows.
3. Manufacturer: This entity is the manufacturer/fabricator of Aluminum Security windows.
4. **Contractor: The Contractor is responsible for the design incorporation, delivery and installation of the GPE products. The Contractor is also responsible for the design and construction of the overall facility, as well as the installation of the GPE items selected by the Contractor in conformance with the overall requirements of the project. The Contractor is responsible for development of a GPE product list and submission of the list to the government for approval, with the design development drawings.]**

E. Related Sections include the following:

1. Division 01 Section "Secure Shipment."
2. Section 033000 “Cast-In-Place Concrete”; for movements and tolerances of concrete building structure elements.
3. Section 055005 “Metal Fabrications.”
4. **[Division 05 Section “Structural Steel”; for movements and tolerances of steel building structure elements.]**
5. Division 07 Section(s) on “Flashing and Sheet Metal.”
6. Division 07 Section “Joint Sealants and Caulking.”
7. Section 080001 “Blast Requirements.”
8. Section 083454 “FE/BR Door Assemblies.”
9. **[Section 084414 “Structurally-Framed Security Curtain Wall System”]**
10. Section 085651 “Aluminum Security Windows”
11. Division 08 Section on general glazing requirements.
12. Section 088855 “Security Glazing.”
13. Section 099602 “High Performance FE/BR Coatings”
14. Other sections of these specifications for interface of door hardware and device units, with alarm/security/safety/access/monitoring systems.

15. **[Division 01 Section on Building Enclosure (FE/BR Windows and Doors) Commissioning.]**

16. **[Division 08 Section “GPE Window and Door Requirements.”]**

1.2 PRE-INSTALLATION MEETINGS

A. Before beginning installation of the FE/BR assemblies, the manufacturer's technical representative shall conduct a pre-installation conference at the Project site with the installation sub-contractor, the electrical sub-contractor, the Project Director/COR, and other interested parties to review installation procedures and manuals, schedules, and coordination of the FE/BR-assembly installation with other elements of the Work.

1.3 REGULATIONS AND STANDARDS

A. Standards and codes referenced in this Specification shall be those editions, including amendments, current at the date of this Specification.

B. In the event of a conflict between referenced codes and standards and/or the Drawings and Specifications, the code or standard having the more stringent requirements shall govern.

C. Comply with the following industry Standards, unless more stringent requirements are indicated or are required by an approved product manufacturer, use metric versions of the standards if available:

1. American Institute of Steel Construction (AISC): 303 “Code of Standard Practice for Steel Buildings and Bridges,” 341 “Seismic Provisions for Structural Steel Buildings,” and 360 “Specification for Structural Steel Buildings.”
2. American Iron and Steel Institute (AISI): Steel designations.
3. American Welding Society (AWS): D1.1 “Structural Welding Code - Steel,” D1.2 “Structural Welding Code - Aluminum,” D1.3 “Structural Welding Code - Sheet Steel,” D1.6 “Structural Welding Code - Stainless Steel.”
4. Aluminum Association (AA): “Aluminum Design Manual,” and “Aluminum Standards and Data.”
5. American Society for Testing and Materials (ASTM): Documents specified herein.
6. American National Standards Institute (ANSI): Documents specified herein.
7. American Architectural Manufacturers Association (AAMA): Documents specified herein.
8. Building Hardware Manufacturers Association (BHMA): Hardware finish designations.
9. Consumer Products Safety Commission (CPSC): Documents specified herein.
10. Glass Association of North America (GANA): “Glazing Manual,” “Laminated Glazing Reference Manual,” and “Tempering Division Engineering Standards Manual.”
11. National Association of Architectural Metal Manufacturers (NAAMM): “Metal Finishes Manual.”
12. Research Council on Structural Connections (RCSC): “Specification for Structural Joints Using High-Strength Bolts.”
13. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): “Architectural Sheet Metal Manual.”
14. Steel Structures Painting Council (SSPC): “Steel Structures Painting Manual, Vols. 1 & 2.”

1.4 ACTION SUBMITTALS

A. General:

1. All submissions must be in accordance with Division 01 Specifications.
2. Submit shop drawings, samples, data, reports, and engineering calculations for the Project Director/COR 's approval before proceeding with the Work of this Section. Upon award of contract, provide a submittal log which indicates submittal packages and sequence, as well as a list of major products proposed to be furnished. Submissions shall be made according to a schedule that allows adequate time for review and approval by the Project Director/COR as stated in the General Conditions.
3. Submissions shall be complete and comprehensive and include all shop drawings, samples, material data submissions, and engineering calculations for the part of the window addressed. All work shall be coordinated by the Contractor prior to submission. Incomplete, non-conforming, or uncoordinated submissions shall be subject to rejection or return without action by the Project Director/COR. Any work executed which deviates from the approved shop drawings and submittals shall be subject to rejection.

B. Product data for manufactured fabricated aluminum window units. Include information for metals and alloys, fasteners, welding, applied finishes, hardware, and accessories. Include producer's detailed instructions for assembly, protection, installation, and maintenance. Note any maintenance information that may adversely affect the glazing according to section 088855 “Security Glazing.”

1. Manufacturer’s standard color chart.

C. Shop drawings:

1. All shop drawings showing blast resistant window assemblies shall be signed and stamped by window vendor’s blast consultant. All sheets shall be of one size and shall bear the seal of an engineer licensed in the appropriate jurisdiction.
2. Show dimensioned detail of aluminum window units and adjacent construction.
3. Show application of intended glazing materials.
4. Show typical window unit interior and exterior elevations at not less than 1:20 scale.
5. Submit shop drawings in PDF format. After final modifications and corrections have been incorporated, submit drawings as AutoCAD files with .DWG extension as well as in PDF format.
6. Cover sheet: Include manufacturer's name, address, telephone, and facsimile numbers; customer and address; project location; contract or purchase order number; and submittal release record.
7. Unit Information:

    a. Manufacturer's model number
    b. Government certification number.
    c. 4-Digit DOS Code.
    d. Mark (window no.).
    e. Window/frame finish.
    f. Window type.
    g. Performance ratings.
    h. Structural wind loading.
    i. Air infiltration.
    j. Water penetration rating.
    k. Thermal movements.
    l. Energy performance.
    m. Sound transmission.
    n. Fire rating.
    o. Glazing panel weights.

8. Elevation Drawings:

    a. Rough opening dimensions.
    b. Frame opening dimensions.
    c. Vision opening dimensions.
    d. Substrate/rough opening material.

e. Manufacturer's name and reference numbers for primer and finish paint, including number of coats applied and thickness of each coat in accordance with Section 099602 “High-Performance FE/BR Coatings.”
f. Separate steel sub-frames (number and list).
g. Detail symbols.
h. Glazing panel dimensions.

9. Plan Drawings:

a. Relate to elevation on drawing.
b. Identify "Attack" and "Protected" sides.
c. Provide key notes on drawings.
d. Indicate room space numbers taken from Contract Drawings.

10. Details:

a. Clearly illustrate all aspects of the windows including:

1) The relationship of the windows to the building structure, roofing and waterproofing systems, interior finishes, and other adjacent construction.
2) The arrangement of components.
3) Full size details indicating: sealing, flashing, weeping, and jointing; all dimensions and thicknesses; materials and finishes; material, type, size, location, and spacing of screws, bolts, welds, anchoring devices, and glazing accessories; locations of conduit entry into both subframe and window frame (where applicable).
4) Steel frames and subframes including plan and section details and corner conditions.
5) Details shall include all components, fully coordinated and integrated, regardless of the component provider.
6) Include sizes and strength of anchor, fasteners and washers.
7) Window and frame gauge thickness.
8) Covers (snap-on or mechanically attached) thickness and profiles.
9) Electrical access, where applicable.
10) Torque (nm) for anchor bolts.

b. Include details of all connections and seals to contiguous work as approved by the Subcontractor for the work adjacent and include all assumptions regarding the tolerances of that work.
c. Details shall be on separate sheets from plan and elevation drawings.

11. General Product Information: Include notes sheet, miscellaneous materials specifications, abbreviations, glazing layup sheet, finish/paint system, legend, and glazing specifications.
12. Breakdown of Product Line Items:

a. If Manufacturer produces one contract line item as several parts, they shall break out items on drawings. Each item shall be a subdivision of that product line item number. Indicate manufacturer’s part numbers for all components.

D. Engineering Calculations:

1. Submit project-specific engineering calculations as described in the Part 2 Article on PERFORMANCE REQUIREMENTS.
2. Submit engineering calculations concurrently with corresponding shop drawings.
3. Insert appropriate location.
4. Calculations shall bear the seal of a Professional Engineer licensed in the appropriate jurisdiction.

E. Blast Report: Refer to Section 080001 “Blast Requirements” for blast report.

F. LEED Submittal:

1. Product Data for Credit MRc2: Environmental Product Declarations
2. Product Data for Credit MRc3: Recycled Content
3. Product Data for Credit MRc4: Health Product Declarations
4. Product Data for Credit IEQc2, Low Emitting Materials: For glazing sealants used inside of the weatherproofing system, including certificate of VOC emissions and content.

G. Samples for Verification: For windows and components required, prepared on Samples of size indicated below. Submit samples to Project Director/COR at project site.

1. Submit samples of all materials and finishes, including:

   a. Samples matching the appearance, color, texture, and other characteristics of each finish required; Samples may be of a standard extrusion with similar properties and will be reviewed visually by the Project Director/COR for color and texture/sheen.
   b. Range samples showing the complete range of variation in color, texture, and other characteristics resulting from the carefully controlled manufacture, finishing, fabricating, delivery, assembly, installation and cleaning processes;
   c. Finished samples of major extrusions;
   d. Finished samples of each sheet in thickness and type required;
   e. Samples showing finishes over welds and over materials welded.

2. Submit four identical pieces of each sample required.
3. The Manufacturer and Contractor shall provide samples of production materials shall be provided by the following sizes:

   a. Fastening devices: Each type.
   b. Finish hardware: Each type.
   c. Finish samples: 30 cm x 30 cm, each type and finish.
   d. Finished extrusions: 30 cm in length.
   e. Finished sheet: 30 cm x 30 cm, each type.
   f. Flashing: 30 cm long, each type. Include lap or splice jointing.
   g. Glass: 30 cm x 30 cm, each type and edge finish.

h. For insulating glass units provide assemblies representative of units to be used in the finished work, including scheduled glass, coatings, spacers, edge seals, and edge deletion.
i. Sealants: Cured sample, 30 cm long, each type.

4. [Window Corner Fabrication: Provide one 300-by-300-mm (12-by-12-inch) sample for record to OBO. Sample shall include a full-size sections of extrusions with factory-applied color finish, cladding and removable covers, weatherstripping, and glazing. If directed by OBO, when a current sample is available at OBO headquarters, an additional sample is not required]

H. Condensation Resistance Simulations:

1. Submit computer simulation results confirming conformance with specified condensation resistance performance criteria.

1.5 INFORMATIONAL SUBMITTALS

A. Installer Qualifications:

1. For FE/BR/Blast installations, submit crew leader resumes documenting the lead installers have installed FE/BR/blast assemblies for a DOS project within the last 5 years.
2. Submit list of installer's personnel who have received the manufacturer's training according to the requirements in the Part 1 Article on QUALITY ASSURANCE.

B. Copy of DOS Certification Letter: Copy of DOS Certification letter indicating that products have been certified by the Bureau of Diplomatic Security (DS) in accordance with DS/PSP/PSD SD-STD-01.01, Rev H.

C. Certificates of Compliance:

1. Completed certificates of compliance documenting that all FE/BR assemblies have been installed per the contract documents. Complete and submit to the Project Director/COR the form referenced in the Part 1 Article on QUALITY ASSURANCE. Certificate of Compliance form is found at end of this Section.

D. [Energy Performance Certificates: NFRC certified energy performance values for each glazed wall system.]

E. Test Reports:

1. General: Submit test reports in a timely manner and well before execution of any related component of the windows.

2. Submit laboratory test reports, showing compliance with performances required for air infiltration and water penetration.

F. Installation Instructions:

1. Provide standard window installation and glazing panel replacement instructions and customized supplement for each type of application that varies from the standard window installations. Installation manual and supplement shall be approved by the OBO/CFSM/SM/SOD/PSO/FE/BR Program Section.
2. Manual shall be customized for each type of application.
3. Manual shall identify in the installation steps where “products by others” such as flashing and finishes surrounding the product are to inface/take place. Installations steps for “products by others” is not required.
4. Develop instructions for unique conditions as they are identified.
5. Manual shall include step-by-step instructions for installing FE/BR doors with supporting photos, illustrations and figures that also includes sections for General Requirements, List of Tools & Expendable Supplies, Window Removal from Crate, and Cleaning.
6. Manufacturer’s Technical Representative shall submit list of unique project specific site conditions that require special manufacturer representative inspection and/or installation training.

G. Quality Control Program: Submit prior to start of fabrication. See Part 1 Article on QUALITY ASSURANCE.

1.6 CLOSEOUT SUBMITTALS

A. Special Warranty: Provide special warranty in accordance with the Part 1 Article on WARRANTY.

B. Maintenance Manuals:

1. At the completion of the Project, **[submit four bound copies of][digitally submit]** a maintenance manual for all window components. Include instructions for cleaning, repair, and maintenance of the work, including re-glazing procedures within the manual or as a separate manual. Include warranties, manufacturer’s data and contact information for all components.

C. Installation and Maintenance Instructions: At the completion of the project, digitally submit a maintenance manual for all security glazing components. Include the following information:

1. Glazing replacement instruction or manual which includes step-by-step instructions with photographs and illustrations for all window conditions on the project and includes the following information:

a. List of tools and expendable supplies.
b. Removal of the damaged glazing.
c. Cleaning the window frame.
d. Removal of the replacement glazing from the crate.

e. Transporting the glazing on a heavy-duty glass cart from the loading dock to window location.
f. Positioning the new replacement setting blocks and any glazing tape or foam on the frame and/or glazing pocket as appropriate.
g. Lifting the glazing from the cart with a glazing robot into the window frame
h. Installing the glazing stops.
i. Inserting any gaskets or applying any sealant as appropriate.
j. Best practices recommendations for glazing replacement:
k. Removal of the replacement glazing from the crate.
l. Transporting the glazing on a heavy-duty glass cart from the loading dock to window location.

2. Instructions for cleaning.
3. Copies of Warranties.
4. Copies of Manufacturer's product data.
5. Contact information for manufacturers and suppliers of all components.

D. Record Shop Drawings: At the completion of the Project, **[submit four bound sets of half-size prints of] [digitally submit]** all final approved shop drawings.

1.7 QUALITY ASSURANCE

A. Testing Laboratory Qualifications: For compliance with non-security performance requirements on security window assemblies of this Section, use only those testing laboratories which have successfully demonstrated to Project Director/COR that they have experience and capabilities needed to satisfactorily conduct required tests.

B. Delegated Design Responsibility: Contractor shall retain an experienced Professional Engineer, registered in the U.S. or in country with significant experience with windows of similar complex performance requirements, and acceptable to the Project Director/COR, to perform responsibilities of Delegated Design.

C. Quality Control for Forced-Entry/Ballistic Resistant (FE/BR) Products: Certify compliance of fabricated and assembled FE/BR products specified in this Section with each quality control procedure established by the Government; these procedures are identified in Compliance Form found at end of this Section. Other quality control forms are found at end of Section 083454 "Forced Entry (FE) / Ballistic Resistant (BR) Door Assemblies."

D. Installer Qualification Data: The installer's qualifications must be approved by the Office of Overseas Buildings Operations, Construction Facilities Security Management, Security Management, Security Countermeasures Division, Security Engineering Branch (OBO/CFSM/SM/SCD/SEB). Submit resumes of all team lead installer (present and responsible for each install), documenting that installer has installed FE/BR window assemblies for DOS projects with last five years. Resume shall include at least three references (including contract information) that can provide verification that the installer has expertise required to perform successful installation. Each installer or installation team must be certified by the manufacturer as being capable of properly installing the FE/BR products. The installer must provide written

documentation to the Project Director/COR that the installation team is certified in the manufacturer's product installation.

E. Manufacturer's Technical Representative: **[The manufacturer shall appoint a manufacturer's technical representative to the project.] [For GPE projects the contractor will hire from the manufacturer a technical representative.]** The manufacturer's technical representative shall be an employee of the manufacturer and have the following responsibilities:

1. Pre-Installation Conference: See Part 1 Article on PRE-INSTALLATION MEETINGS for the representative's responsibilities.
2. Training: The manufacturer's technical representative (at no cost to the U.S. Government) shall provide the crew, which is to actually perform the installations of the FE/BR assemblies with a minimum of 16 hours of on-site, hands-on training which shall include the complete installation of at least three FE/BR windows, with the exception of the snap on trim, and training on glazing replacement and completion of the Certificate of Completion for each of the three windows. The manufacturer's technical representative shall also instruct the crew on preventive measures which must be taken to protect the FE/BR assemblies from damage during construction.
3. Inspection: See Part 3 Article on FIELD QUALITY CONTROL FOR THE GENERAL CONTRACTOR/INSTALLATION CONTRACTOR for the representative's responsibilities.
4. Additional Assistance to the Government: The manufacturer's technical representative (at no cost to the U.S. Government) shall provide the Contractor any additional advice, instruction, training, supervision, or inspection required to enable the Contractor to complete the installation certification described below, and to fully train the Embassy staff in the proper operation and maintenance of the FE/BR assemblies while on site before turn over to the DOS.

F. Certification by General Contractor: Prior to final completion, the General Contractor shall provide to the Project Director/COR a certification that the FE/BR materials have been installed in accordance with the manufacturer's instructions, these specifications and are operational. Sample Certificates of Compliance are attached to the end of this specification. Deviation from these requirements is only permitted with the written approval of OBO/CFSM/SM/SCD/SEB or OBO/CFCM/SM/SOD/PSO/FE/BR. The General Contractor shall provide certification that the requirements in these specifications have been included in the work. The following requirements are part of this Certification.

1. The manufacturer's technical representative was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing security teller windows has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.
2. Employees performing the installation meet the specified training and experience qualifications.
3. Each sub-frame has been installed level, plumb and square.
4. All sub-frame assemblies shall be factory welded together. Any large sections that exceed the limits of a standard shipping container shall be clearly identified for field welds.
5. All units have been pre-glazed at the factory.
6. All temporary fasteners have been replaced with permanent fasteners.

7. All frame fasteners and threaded openings in subframe have been cleaned of all oil and debris, and have been dry-torqued to meet the manufacturer's specifications. Shims have been inserted at all bolt locations, minimum 1 shim per bolt and maximum as tested condition.
8. Frame bolts/screws are as shown on the approved shop drawings.
9. Finish materials do not overlap the window frame/sub-frame or shim space and ballistic trim bars in such a way that the window cannot be re-glazed unless the surrounding finishes and trim are demolished; unless the finish materials can be easily removed and reinstalled. All overlapping finish work (i.e. metal, wood, stone, etc.) can be removed without damaging the window and finish.
10. Any cladding that covers window glazing stops (angles or tubes) is attached to the frames with hidden fasteners or snap on covers for easy removal.
11. Any cladding that covers the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cap plugs and cladding for each window have been bagged and won't be installed until after the final QA inspection has been conducted by the OBO/CFSM/SMSCD/SEB representative.
12. Separate pieces of ballistic trim have been installed, as indicated in the approved shop drawings.
13. Ballistic trim bars have been secured/screwed to the sub-frame and not the window frame.
14. Ballistic trim bars have been installed tight against the window frame, or sill flashing, and gap shall not exceed 2 mm or as tested by the manufacturer.
15. Maximum gap at shim space shall be no more than then the tested and DS certified assembly, except as noted in the requirements for "Window Flashings" within the Part 3 Article on INSTALLATION.
16. The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers (see Part 1 Article on IDENTIFICATION SYSTEMS below).
17. Deal Tray: Ensure deal tray cover is installed. Ensure no sharp edges.
18. Deal Drawer: Ensure drawer opens and closes without binding or scraping. Ensure not sharp edges.

G. Quality Control inspection documents shall incorporate:

1. Security Glazing Requirements including the following:

   a. Whether internal channels are used to separate glass from polycarbonate or otherwise framed for solid laminated glazing, minimum glazing depth in openings (bite) for attack and protected sides which shall not be less than 20 mm and 6 mm cushion clearance to fixed stop on glazing edges.

H. Quality Control Program:

1. Quality Control Program shall cover all phases of the window Work including, but not necessarily limited to, the following:

   a. Procurement of materials, including quality assurance programs of major suppliers.
   b. Fabrication of components.
   c. Production testing.
   d. Final assembly of components.

e. Installation and site quality control.

2. Quality Control Program shall indicate the following for each quality control measure/activity:

   a. Item/property being inspected/tested
   b. Control point in process and frequency of inspection/testing
   c. Inspection/test method
   d. Acceptance criteria and reference standards/specifications
   e. Method of documentation
   f. Action to address deficiencies

3. Quality Control Program shall include detailed descriptions of inspection and production testing programs and inspection reports for:

   a. Coatings of metal. Coordinate and include controls by metal fabricator and finisher, as well as by Contractor to provide independent checks of metal quality and finish at point of fabrication, finishing, and during installation
   b. Structural glazing.

4. At the request of the Project Director/COR, a Government representative shall be allowed access to Contractor's facilities and those of major suppliers at with advance notice to monitor QC procedures. Make available all QC Program records upon request.

1.8 TESTING AND MOCK-UPS

A. [NFRC Testing:

1. Provide, install, and test specimens of the vision-glazed window systems at an NFRC-accredited laboratory as necessary to obtain NFRC certification and labeling.
2. The Contractor or their designee shall be the "Responsible Party" as defined in the NFRC procedures.
3. Obtain certification and "NFRC Label Certificates" prior to installation.]

B. Trial Installations:

1. Refer to the crew training responsibilities in the requirements for "Manufacturer's Technical Representative" in the Part 1 Article on QUALITY ASSURANCE.
2. Prior to general installation of windows, erect on the building a representative trial installation of each window type for the Project Director/COR's approval.
3. Propose the scope and location of trial installations for the Project Director/COR's approval.
4. Notify the Project Director/COR well in advance of each such trial installation. If approved, this portion of the work shall become part of the final installation.
5. Provide a demonstration at the job site where the windows will be installed simulating replacement of a glazing panel at different floor levels using technology (,e.g., roof

mounted davit & winch systems from the exterior or glazing robot from the interior along with two workers on each side, exterior and interior, accessing the window head, jambs and sill).

C. Pre-Construction Sealant Testing:

1. Test proposed field applied sealants for adhesion and compatibility with each type and color of substrate or material coming into contact with them.
2. Test proposed sealants for staining of each type and color of porous substrate or material coming into contact with them, including other sealants.
3. Test specimens shall be of the size required by the manufacturer's testing laboratory and shall be composed of the specified materials, colors and finishes.
4. Adhesion testing: ASTM C794.
5. Compatibility testing: ASTM C1087.
6. Stain testing: ASTM C1248.
7. Tests shall be performed by the sealant manufacturer whose products are being considered.

D. Structural Silicone Testing:

1. Test silicone joints proposed for structural glazing for performance in tension, shear, and tension and shear combined, in accordance with ASTM C1135.
2. Test specimens: approximately 5 cm in length, full dimension in width and depth, and be composed of the specified materials, colors and finishes.
3. Ten specimens for each condition shall be tested and the values for elongation-to-failure vs stress recorded for each specimen, and the mean and standard deviation calculated for each condition.
4. Tests shall be performed by the structural silicone sealant manufacturer whose products are being considered.
5. In addition to the above, production testing shall be performed at regular intervals during assembly of the window, as specified.

E. Acoustical Testing

1. Test window and deal tray and/or transaction drawer combination in the project configuration in accordance with ASTM E90, "Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."

1.9 IDENTIFICATION SYSTEMS

A. Identify each assembly to provide Government with ready reference to original manufacturer to facilitate reorders, replacement parts, service, resolution of complaints, and inventory. Provide a steel stamped ID plate. Locate one plate on the lower right corner (hidden) of the secure side of the window frame. Locate one plate on lower right of the interior window frame snap on trim or cladding (visible). The plate shall be approximately 40 x 75 mm, must be easily accessible and shall cite:

1. Manufacturer's name/city/state.
2. Government certification DOS model number.

3. Contract number.
4. Month/year of manufacture.
5. Mark number.
6. 4-digit DOS CODE

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver each assembly to project site with fabrication, finishing, and assembly of primary panels, sub-frames, and frames completed and prepared for installation and connection with security systems. Refer to Division 01 Section “Secure Shipment” for additional requirements.

B. Deliver window assemblies as factory glazed unless otherwise directed by Government.

C. Pack window assemblies and accessories; One crate for the window and frame, including installation accessories: All anchors, bolts, screws, shims, ballistic trim, shop drawings, etc. Provide a separate compartment, and clearly label each crate for each type of component. Removable covers/trim and sub-frames may be shipped separately. Multi-unit elevations may separate the ballistic bolts, ballistic bars and trims which span, or are shared, by several unites into separate crates. With OBO/CFSM/CM approval bulk packaging of like materials, may be approved on a case-by-case basis.

D. Provide protection of frame exposed finishes using surface protection film.

E. Treat security window assemblies as fragile merchandise, and packaged and shipped in export wood crates, not constructed of Oriented Strand Board (OSB), with width end in upright position and blocked together in a mass, except as noted below. Do not use plastic or polyethylene sheeting, or extruded polystyrene. Comply with Manufacturer's directions for storage and handling to prevent edge damage or other damage to assembly resulting from effects of moisture, condensation, temperature changes, direct exposure to sun, and contact with chemical solvents, and ground contaminants. Clearly mark crates to indicate which side should be opened first.

1. If the window is designed to be shipped on the jamb side, to include setting blocks on the jamb side, and label jamb and crate “ALTERNATE SILL” and indicated orientation.

F. Clearly mark sub-frames with window mark number and identify attack side, head, sill, and left and right jambs. Package sub-frames separately and ship in export wood crates separate from the window assemblies. Protect each sub-frame piece to minimize damage to finished surfaces.

G. Conduct thorough visual inspections of the glazing prior to packaging.

H. Include a complete list of non-compatible materials for temporary protection during construction and cleaning.

I. Include tip and tell, temperature, and humidity indicators with packaging, one for each crate, located on exterior of the crates and one of each on interior of crates. Manufacturer shall provide one crate label, located next to exterior tip and tell and one fly sheet with the packing material indicating the humidity maximum limits allowed for the glazing.

J. Store materials in a dry, well-ventilated location. Keep handling of materials to a minimum, and carefully protect materials from soiling and from condensation and other harmful moisture. Provide vapor-permeable materials for protection during shipping. Do not trap moisture within or adjacent to windows.

K. Conduct thorough visual inspections of glazing before installation. Inspections should include removal of glazing stops, if applicable. Do not install glazing with any cracks in the polycarbonate. Contractor shall remove film after doors and windows are installed on project site.

1.11 WARRANTY

A. Special Warranty: Written warranty in which Contractor agrees to repair or replace components of the windows that do not comply with requirements or that fail in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Abnormal deterioration, aging and weathering of the windows;
b. Leakage of water or air exceeding specified limits;
c. Structural failure of components resulting from exposure to pressures and forces within specified limits;
d. Failure of operating parts to function normally;
e. Deterioration/discoloration of finishes in excess of normal weathering and aging;
f. Glass breakage due to defective design, manufacture, or installation;
g. Edge separation or any other deterioration whatsoever of laminated glass;
h. Cracking or crazing of polycarbonate glazing;
i. Failure of the windows to meet any other specified performance requirements.
j. Warranty Period: Five years from date of Substantial Completion.

B. Warranty, Organic Coatings: See Section 099602 “High-Performance FE/BR Coatings.”

C. Manufacturer’s Special Warranties for Structural and Weatherseal Sealants:

1. Written warranties in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that fail to provide airtight and watertight joints, or fail in adhesion, cohesion, abrasion resistance, stain resistance, weather resistance, or general durability or appear to deteriorate in any other manner not clearly specified in the manufacturers data as an inherent quality of the material.
2. Warranty Period: 10 years from date of Substantial Completion
3. Glazing Period: See requirements for special product warranties in Section 88855, “Security Glazing.”

1.12 EXTRA MATERIALS

A. Furnish extra materials identified below. Package extra materials with protective coating for storage and identification labels describing contents.

1. Glazing panels: Two vision and two spandrel units for each module, glazing type and size.
2. Frame retention set screws and other non-perishable parts required for re-glazing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design of the windows (including comprehensive structural analysis) shall be performed by a professional engineer. Refer to the Part 1 Article on QUALITY ASSURANCE for required qualifications. Responsibilities also include design and integration of associated security glazing and ensuring conformance to performance requirements for security glazing; see Section 088855 “Security Glazing.”

1. Applicable Criteria: Utilize criteria identified below, including criteria such as seismic and other loads. Engineering design development, materials and methods of construction other than that indicated or implied by the Contract Documents may be employed when such materials and methods when they are consistent with these criteria. Any deviations from these, or clarification where there are apparent conflicts with these, must be obtained from the Project Director/COR.

a. Performance requirements identified in this Article.
b. Other applicable criteria included within the OBO Design Standards (e.g., OBO Codes, reference documents).
c. Design intent documents prepared by the A/E involved with RFP documentation, and consistent with these performance requirements and other criteria in the OBO Design Standards.

2. Contractor’s Professional Engineer’s Responsibilities:

a. The Contractor’s Professional Engineer shall prepare and endorse complete engineering design and calculations and shall check and monitor the preparation of all shop drawings for conformance with the engineering design and calculations, and for compliance with the Contract Documents.
b. Engineer shall submit structural calculations for all components of the windows and indicate ultimate factors of safety.
c. As evidence of conformance to these requirements, each shop drawing and calculation sheet shall bear the seal and self-written signature of the Engineer.

B. General: Fabricate and install aluminum framed window units anchored to steel subframes to achieve the following security-related resistances, along with other indicated performances. Extend resistance to include anchorages and interfaces with adjoining substrates. Provide window rating as listed on the window schedule.

1. Forced-Entry (FE) resistance rating for attack with ordinary hand tools for the following ratings of the Physical Security Division of the Bureau of Diplomatic Security (DS/PSP/PSD).

   a. Government Code 1: No FE resistance rating.
   b. Government Code 2: 15 minutes.
   c. Government Code 3: 60 minutes.
   d. Government Code 4: 5 minutes.

2. Ballistic Resistance (BR) assemblies: Where window assembly is shown or scheduled as BR, provide the following ratings:

   a. Government Code 1: No BR resistance rating.
   b. Government Code 2: Submachine gun, 9 mm.
   c. Government Code 3: Rifle, 5.56 & 7.62 NATO.
   d. Government Code 4: Armor piercing, 0.30-06.

TABLE 2.1 - WINDOW CODES

DOS CODE	1ST DIGIT – TELLER WINDOW COMPOSITION	2ND DIGIT FIRE RATING	3RD DIGIT – FORCED-ENTRY RATING	4TH DIGIT – BALLISTIC RESISTANCE RATING
1	Transparent	None	None	None
2	Opaque	1.5 hours (Class D at exterior)	15 minutes	Not Used
3	Not Used	3 hours (Class A)	60 minutes	Rifle 5.56 & 7.62 NATO
4	Not Used	45 minutes (Class C)	5 minutes	Armor-Piercing (.30-06)

3. Provide combined performances for indicated requirements, with each performance surviving combined attacks within rating limitations of performance, but recognizing that certain forms of attack may result in severe damage to units, even though repelled successfully, leading to need for replacement of units, or of damaged elements of units.

C. Blast Resistance: See Section 080001 “Blast Requirements.”

D. Ballistics-Resistance Performance: Provide units identical to those tested for compliance with the following requirements:

1. Certified as complying with SD-STD-01.01, Revision H, by the U.S. State Department, for ballistics resistance when tested by a qualified testing agency.

E. Forced-Entry-Resistance Performance: Provide units identical to those tested for compliance with the following requirements:

1. Certified as complying with SD-STD-01.01, Revision H, by the U.S. State Department, for forced-entry resistance when tested by a qualified testing agency.
2. If blast, or other requirements, result in changes to the tested FE/BR design, including anchor or other material changes, the FE/BR vendor shall contact DS/PSP/PSD/RD to determine if a technical review is required.

    a. Shop drawings shall include the TR model number, where applicable.

F. Climb Resistance: Where applicable, conform to the climb-resistance requirements and criteria in the OBO Building Code.

G. Deal Trays: Provide deal trays for teller windows that are designed to prevent ricochet of projectiles towards protected side of window assembly. Deal trays shall provide minimum clear openings of 500 mm in width, 350 mm in depth and 50 mm height. Deal trays shall also be capable of allowing easy passage of a 325 mm by 380 mm envelope containing 100 sheets of legal size documents. All deal tray designs are subject to OBO approval by OBO/CFSM/SM/SCD/SEB or OBO/CFCM/SM/SOD/PSO/FE/BR. At teller windows, provide manufacturer's standard cover for pass-through, operable only from secure side, with nominal closure door or feature, which will obstruct passage of paper and other objects, the flow of moisture and gas through unit, and gasket to minimize sound transfer. Deal tray assembly shall be free from sharp edges or projections.

H. Transaction Drawers: Provide FE/BR transaction drawers in lieu of deal trays for exterior applications and where indicated in the construction documents. Transaction drawers shall also be capable of allowing easy passage of a 325 mm by 380 mm envelope containing 100 sheets of legal size documents. Drawer shall provide positive closing device to keep drawer closed unless unengaged to open. Provide handle to open and close drawer. Provide concealed drain feature to drain unit to threat side. All transaction drawer designs are subject to OBO approval by OBO/CFSM/SM/SCD/SEB or OBO/CFCM/SM/SOD/PSO/FE/BR. Drawer assembly shall be free of sharp edges or projections, or pinch points around handle.

I. Transaction window communication: Provide path for communication wiring through window unit from the protected side to the attack side. Path should provide a protected path that maintains ballistic protection performance and allows for easy installation and maintenance of electronic communication at the transaction window. Type of communication is determined by the location and the design.

J. Structural Performance: Aluminum security windows shall withstand the effects of wind loads determined as follows, with no permanent deformation or breakage within window assembly when designed in according to ASCE 7-16, as adopted and amended by the OBO Building Code, and tested according to ASTM E 330:

1. Basic Wind Speed: Shall be as indicated in the Structural Drawings.

K. Structural Glazing Sealant Bite: Sealant bite shall be adequate to resist specified loads.

L. Snap-on Components: Concentrated load of 4.5 kg (10 lbs.) at any point.

M. Air Infiltration for Fixed Windows: Not more than 0.2 L/s per sq. m (0.04 cfm/sq. ft.) at an inward test pressure of 300 Pa (6.27 lbf/sq. ft.) when tested according to ASTM E 283.

N. Water Penetration:

1. Under Static Pressure: No evidence of water penetration through fixed glazing when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 480 Pa (10 lbf/sq. ft.).
2. Under Dynamic Pressure: No evidence of water penetration through fixed glazing when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 480 Pa (10 lbf/sq. ft.).
3. Maximum Water Leakage: Water penetration shall be defined as any water, other than condensation, that appears on any interior surface of the window, or on any surface inside the concealed spaces of the window or adjacent construction not designed specifically to function as part of the rainwater management system for the building enclosure. This definition of water penetration governs over those found in referenced documents.

O. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:

1. Temperature Change (Range): **[67 deg C (120 deg F)]**, ambient; **[100 deg C (180 deg F)]**, material surfaces **<Edit for local conditions>**
2. Test Interior Ambient-Air Temperature: 24 deg C (75 deg F).
3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

P. Energy Performance: **[Exterior security teller windows shall have certified and labeled energy performance ratings in accordance with NFRC.]**

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than **[1.5]** W/sq. m x K (**[0.40]** Btu/sq. ft. x h x deg F) as determined according to NFRC 100.
2. Solar Heat Gain Coefficient (SHGC): Refer to Section 088855 “Security Glazing” for limitations on performance requirements for certain glazing.
3. Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than **[0.47]** as determined according to NFRC 200, or as identified in the specified glazing type in Section 088855 “Security Glazing.”

   a. Fixed glazing and framing in locations where special coatings using approved coating products are used, a solar heat gain coefficient of no great than **[0.XX] [as determined according to NFRC 200]**.

4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than **[55]** as determined according to NFRC 500.

Q. Visible Light Transmittance (VLT): Refer to Section 088855 “Security Glazing” for limitations on performance requirements for certain glazed assemblies.

R. Sound Transmission: Provide aluminum windows with fixed glazing and framing areas and associated deal trays and/or transaction drawers having the following sound-transmission characteristics:

1. Outdoor-Indoor Transmission Class (OITC): Minimum 35 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
2. Acoustical performance shall be minimum STC 40 for interior teller window and deal tray with deal tray cover in the closed position.

S. Facilitation of Glazing Replacement: Install aluminum security window assemblies only into a steel substrate in such a manner that allows for future glazing panel replacement. This may be either a structural steel wall or other structural steel assembly, a steel sub-frame in concrete, or a steel sub-frame attached to concrete**[or masonry]**.

T. Mullions: Provide mullions between window units that are designed to provide thermal isolation and performance equal to the performance of the adjacent window unit frames. Mullions must meet all applicable FE/BR and/or blast requirements, and shall not degrade acoustical performance

U. Building Structure Movements and Tolerances:

1. The windows shall accommodate differential structural movements, deflections, interstory drift, and thermal movement of the building structure due to gravity loads, wind loads, seismic loads and temperature.
2. The windows shall accommodate the following without distress, disengagement, or damage:

   a. Slab or Perimeter beam deflection due to service live load, column shortening, and differential long term creep.
   b. Interstory lateral drift (serviceability).

3. The windows shall accommodate the following without detachment of components from the building or glass fallout:

   a. Inter-story lateral drift (ultimate).

4. The windows, including its connections to the building structure, shall accommodate the fabrication and erection tolerances allowed for the building structure.

   a. Slabs, beams, and columns; left/right and up/down.

5. It is the responsibility of the Contractor to refer to the appropriate specifications of Cast-In-Place Concrete, Structural Steel, or Metal Framing for the full description of structural movements and tolerances.

V. Animal Nuisance Control:

1. The windows shall inhibit the entry of insects or other small animals which would constitute a nuisance by their presence.

W. [Fire Safety:

1. Provide fire-resistance rated assemblies, as indicated in Contract Documents, and as required to conform to OBO Codes (OBO-adopted model codes as amended by OBO Code Supplements).]

2.2 MANUFACTURER/FABRICATOR

A. Selection of fabricator/manufacturer for each type of security window assembly, and selection of manufactured elements which are used in make-up of that assembly, are Contractor's options subject to the following requirements and limitations, approval by the Project Director/COR and subject to general provisions of Construction Contract:

1. Pre-certified fabricators of ballistic--resistant and forced-entry-resistant assemblies are identified in a separate Contract attachment labeled “Government Certified FE/BR Products and Designs".

2.3 METALS

A. Select the alloy, degree of alloy control, homogeneity, temper, metallurgical quality, degree of hardness or softness, mill tolerances, cutting tolerances and flatness, required to achieve the requirements of design, quality, and color matching of finish set forth in Drawings and Specifications.

B. Aluminum:

1. Flat sheet: AA **[3003 for painted finish] [5005 for anodized finish]** H14, ASTM B209, stretcher-leveled and stress-relieved.
2. Extrusions: AA 6061-T6 or AA 6063-T5 or T6; ASTM B221.
3. Other flat sheets and extrusion grades and selection may be allowed with the approval of OBO/CFSM/SM/SCD/SEB, but in all cases, they should not only meet the physical requirements, but ability to finish the material shall be similar.

   a. Extruded aluminum cladding for mullion caps shall be minimum 2.4 mm thick.
   b. Cladding for other exterior applications shall be of a gauge capable of retaining flatness and consistency with no oil-canning or other distortion when subjected to the design wind pressures required for the project, but not less than 1.2 mm thick.

C. Carbon Steel:

1. Rolled shapes, plates and bars: ASTM A36, A572, A992.
2. Hollow steel sections (HSS): ASTM A500
3. Cold rolled sheet and strip: ASTM A1008.
4. Hot rolled sheet and strip: ASTM A1011.
5. Fasteners:

    a. Bolts and Screws: ASTM A307 or F3125 Grade A325 or A490.
    b. Socket Head Cap Screws: M12, Zinc-plated.

        1) For non-blast rated windows: Class 10.9 (Grade 8) or Class 12.9.
        2) For blast rated windows: As required by blast analysis report; see Section 080001 “Blast Requirements.”

    c. Washers: Zinc-plated.

        1) For non-blast rated windows: Class 10.9 (Grade 8) or Class 12.9.
        2) For blast rated windows: As required by blast analysis report; see Section 080001 “Blast Requirements.”

    d. Nuts: ASTM A563 or ISO 4032/8673.

D. Stainless Steel:

1. Sheet, plate, bars and strip: ASTM A240, sulfur not to exceed 0.005 percent; ASTM A480, stretcher-leveled and stress-relieved.

    a. Exposed: AISI Type 316
    b. Concealed: AISI Type 304

2. Fasteners: AISI Type 303, 304 or 316 (exterior).

    a. Bolts and screws: ASTM F593.
    b. Nuts: ASTM F594.
    c. Button and countersunk head screws: ASTM F879.

2.4 FABRICATION AND ASSEMBLY

A. General:

1. To the fullest extent practicable, all fabrication and most assembly shall be executed in the shop. Work not shop-assembled shall be shop-fitted to ensure fit. Refer to Part 3 Article on INSTALLATION; any remaining assembly work is part of that activity.
2. Use no materials, equipment or practices that may adversely affect the function, appearance, performance, or long-term durability of the completed windows or adjacent construction.
3. The windows shall be accomplished in compliance with the specified criteria without buckling, opening of joints, undue stress on fasteners, sealants and gaskets, opening of welds, cracking of glass, leakage, noises or other harmful effects.

4. Conform strictly to the materials, finishes, shapes, profiles, sizes, thicknesses, and joint locations required by the Drawings and Specifications.
5. Match all materials to produce continuity of line, texture and color.
6. Work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All work shall be accomplished to the satisfaction of the Project Director/COR.
7. All components exposed in the finished work shall be free from warping, oil-canning effects; the telegraphing of welds, studs, and other fasteners; streaks, tool and die marks.
8. Finish exposed metal edges to match adjacent finished surfaces.

B. Reduce exposure to non-compatible chemical substances including, but not limited to, the following:

1. Phenols.
2. Silicone-based sealants (non-neutral cure agents).
3. Cutting oils.
4. Common cleaning chemicals known to contribute to polycarbonate environmental stress cracking such as ammonia.
5. Isopropyl not allowed unless rinsed with water.
6. Ethylene-propylene rubber (EPDM) setting block and gasket off-gassing compounds.

C. Manufacturer's Standards:

1. Materials, components and systems incorporated in the Work shall be mixed, applied, installed and otherwise used in strict accordance with the recommended standards and procedures of the respective manufacturers.

D. Storage and Handling at Manufacturing and Fabricating Facilities:

1. Refer to Part 1 Article on DELIVERY, STORAGE, AND HANDLING. Those requirements also apply during the fabrication portion of this Section.

E. Jointing and Reinforcing:

1. Accurately fit and firmly secure all exposed metal joints with metal to metal hairline contacts.
2. Install fastenings at an approved spacing.
3. Fasteners shall not penetrate gutters and drainage systems.
4. Screws and fasteners up to and including 8 mm (5/16 inch) diameter and all that are drilled and/or tapped into aluminum shall be 300 series stainless steel.
5. Fasteners 9.5 mm (3/8 inch) diameter and heavier shall be stainless steel or hot-dip galvanized.
6. Jointing and splicing of members shall be concealed. Exposed fasteners shall occur only where expressly permitted by the Project Director/COR. Where exposed in finished surfaces, screw heads shall be Phillips oval-head countersunk type, finish to match adjacent surfaces.
7. Conceal all joint sealants except as noted on the Drawings.

F. Anchors and Connections:

1. Reinforce elements to resist loads imposed upon them by doors, hardware, anchors, and other attachments. The window manufacturer shall provide anchors appropriate for substrate to which window frame and sub-frame is to be fastened.
2. Anchors and connections shall be provided to fully satisfy their required purpose of adjustability, movement and load transfer.
3. Design connections between different materials shall allow for the differential thermal movement of the respective materials.
4. Anchors and connections that do not provide for movement shall prevent such movement by appropriate means.
5. Anchors and connections that are designed for movement shall be of such construction that friction is low enough to allow for such movement without buckling and other damage and without causing binding and noises.
6. Self-drilling, self-threading fasteners shall not be permitted for use into concrete or masonry for the window frame, but is allowed for ballistic trim.
7. Separate metal surfaces shall be designed such that metal does not move on metal. Materials used for this purpose shall be low friction components, sealants or gaskets as applicable.
8. Anchorages to Structural Steel shall not induce rotational forces in supporting members.
9. All anchors and fasteners outboard of the air-seal shall be 300 series stainless steel. All other fasteners shall be stainless steel or zinc-plated steel. Fastener and anchor assemblies shall be detailed to prevent galvanic corrosion.
10. Shim packs that resist compressive forces only may be solid high-impact plastic, Korolath type or equal. Shim packs subject to bending or shear forces shall be stainless steel or HDG steel plates pinned together to form a monolithic shim.
11. Window frames shall have pre-drilled, vertically slotted bolt hole patterns at the jambs and left/right slotted bolt hole patterns at the head and sill, not to exceed as-tested on-center spacing.
12. The manufacturer shall verify substrates involved, and supply any special fastening tools (e.g., special drill or bit) required by anchoring system.
13. The anchor shall be acceptable for shock/short duration loading, and have potential for removal and re-installation during life of building.

G. Welding:

1. Weld steel in accordance with the recommendations of the American Welding Society.
2. Welding shall be done by skilled mechanics qualified by test in the last 12 months as prescribed in the American Welding Society Code and as applicable to the material thickness and type of welded joint on which the welders will be employed.
3. Welding shall be done with electrodes and/or methods recommended by the suppliers of the metals being welded. The type, size, and spacing of welds shall be as shown on the approved shop drawings. Welding materials and methods shall be such as not to cause distortion, discoloration, or result in any other adverse effect on the required profiles and finishes of visible surfaces of the windows.
4. Welding of aluminum alloys and the qualifications of aluminum welders shall conform to the requirements of the Aluminum Association “Specifications for Structures of Aluminum Alloys, Aluminum Construction Manual”.

5. Welding of stainless steel shall be by TIG welding or other methods subject to approval. Use double bevel butt welds, backing bars to remove heat, jigging, tack welds and any other measures necessary to minimize distortion.
6. Remove weld spatter and welding oxides on exposed surfaces. Finish exposed welds to match and blend with adjacent parent metal prior to final finish application.
7. Stud welding shall be done by mechanics trained by the manufacturer of the stud setting system. The manufacturer shall develop specific programs and instructions in cooperation with the fabricator to suit the needs of the specific details. The fabricator shall exercise particular care that all recommendations of the manufacturer are closely followed. Visible marks (telegraphing) on finished surfaces due to welding of studs shall not be acceptable.

H. Sealant and Gasket Applications:

1. Provide sealing mechanisms (sealants and gaskets) where shown on the drawings or required for a permanently weathertight installation. The sealing mechanism for each location and use shall be as indicated on drawings. In those locations where a mechanism is necessary but is not indicated, it shall be of a type recommended by the Contractor and approved by the Project Director/COR.
2. Design all sealed joints in accordance with the recommendations of the sealant and/or gasket manufacturer.
3. Gasket materials shall be appropriate for the function intended and are subject to approval by the Project Director/COR.
4. Submit test samples of all substrate materials to the sealant manufacturer for compatibility and peel adhesion testing.
5. Protect adjoining surfaces not to receive sealants against staining by masking and/or other methods. Conceal sealant joints from view to the extent possible. Do not allow sealants to contact interlayers of laminated glass.
6. Joints and joint surfaces shall be clean, dry, and free of any materials that may have an adverse effect on the performance of the sealant and gasket materials.
7. Sealant application: ASTM C1193.
8. Apply sealants and gaskets under the climatic conditions recommended by the manufacturer(s). Sealant shall not be installed when substrates are wet or when ambient or surface temperature is below 40 deg F. All surfaces to receive sealants shall be treated (cleaned, primed or unprimed) in accordance with the recommendations of the sealant manufacturer. Use no sealant that has started to set in its container or a sealant that has exceeded the shelf life published by the manufacturer.
9. Glazing gaskets shall be vulcanized, injection molded or heat-welded at the corners to form a continuous closure.
10. Fill all joints continuously and completely with sealant, forming a neat uniform, concave bead. Finish the material flush with adjoining surface unless otherwise shown on the Drawings. All sealant surfaces shall be tooled smooth. Upon completion of tooling, immediately remove masking tape from adjacent surfaces.

I. Glass and Glazing:

1. Comply with the GANA “Glazing Manual.”
2. Glazing shall be performed without springing or forcing. Follow all instructions of the glass and glazing materials manufacturers.

3. Glass and glazing materials shall be compatible with each other and adequate for their intended purpose. Each material type shall be as per details and approved Shop Drawings.
4. Protect all adjoining surfaces not to receive glazing materials against staining or damage of any kind.
5. Glazing pockets shall be clean, dry, and free of any materials that might adversely affect the bond and seal of the glazing materials or the drainage of the pockets.
6. Install glass and glazing materials under the climatological conditions recommended by the fabricator.
7. Prime all surfaces to receive glazing materials unless recommended otherwise, in writing, by the manufacturers and approved by the Project Director/COR.
8. Use no sealant that has started to set in its container, nor a sealant that has exceeded the shelf life published by the manufacturer.
9. Do not install sealant unless the ambient and joint surface temperature is at least 40°F and rising.
10. Install exposed sealants so that the top surfaces of the sealant beads are sloped to drain water away from the glass. Exposed sealant surfaces shall be tooled smooth.
11. Setting blocks shall be at least 6 mm (1/4 inch) in thickness, full width of the pocket, and placed at the glass quarter points. They shall be of a length recommended by the glass manufacturer and be configured in such a way as not to impede water drainage of the glazing pocket.
12. Provide jamb blocks on each glass unit supported on four sides. Place and glue blocks at the top and bottom of the glazing pocket 3 mm (1/8 inch) clear of the glass edge.
13. Glass shall be centered in each opening to provide the bite and clearances recommended by the glass manufacturer and approved by the Project Director/COR.
14. Apply no tapes, ribbons or markings to the glass.

J. Structural Glazing:

1. Comply with ASTM C 1401.
2. Wherever possible, silicone glazing design shall permit glazing to the major framing members in the factory.
3. Provide test samples of all substrate materials to the sealant manufacturer for peel adhesion and accelerated weathering testing. Conduct testing with materials and finishes identical in every respect to approved production materials and finishes.
4. Prior to undertaking any structural glazing, submit complete structural glazing procedures, including permissible conditions, temperatures, cure times, temporary restraint design, surface preparation and all other procedures, including quality control inspection program that may be employed.
5. Perform periodic deglazing of structural silicone glazed lites per ASTM C1401 Paragraph 34.4 and the sealant manufacturer's recommendations, at a rate of one unit in the first 10 produced, one in the next 40, one in the next 50, and one every 100 thereafter.
6. Clearance and bite dimensions shall match approved shop drawings.

K. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

1. Provide thermal-break construction that has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.

L. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior for dry glazed units:

M. Mullions with Strong-backs or Steel Connections: Provide thermally improved mullions and cover plates matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

N. Sub-Frames: Provide steel sub-frames/embeds for all FE or FE/BR windows for installation at concrete, masonry, and other non-steel rough openings and for structural steel openings where depth is less than door frame depth. Steel subframe material shall conform to ASTM A36 or ASTM A529 or ASTM A572 for plates, bars, and shapes; and ASTM A500 or ASTM A1085 for hollow structural sections ("steel tubes"). No steel element to receive a threaded fastener shall be less than 12 mm (1/2 inch) thick. For individual openings, sub-frames shall be provided by window supplier. For larger, multi-panel openings, sub-frames may be provided by either window supplier or Contractor; in either case they shall be designed by window supplier and shown with window shop drawings. For larger elevations that require knock-down subframe, provide hot-dipped embeds. Sub-frame depths shall be no less than the window frame depth on side of sub-frame that window is bolted. Steel sub-frame shall be assembled and braced by manufacturer prior to shipping to ensure deformations during transportation. Ensure steel sub-frame is braced so that deformation tolerances are not exceeded during installation and concrete placement. Where sub-frames are hot-dipped galvanized, temporary supports shall be designed and detailed not to damage to the galvanized surfaces during use and removal. Steel sub-frame shall be installed plumb and square. All sub-frames without adjustability shall be drilled and tapped in the field.

1. Exterior sub-frames/embeds and shall be hot-dipped galvanized for corrosion resistance.
2. Interior sub-frames/embeds shall be prime painted with a high-grade metal primer or may be hot dipped galvanized.

O. Post-installed Anchors: In addition to any restrictions or requirements indicated on the Construction Drawings, post-installed anchor systems proposed by the Contractor's delegated design shall each have ICC-ES Evaluation Report indicating conformance with current applicable ICC-ES Acceptance Criteria including, but not limited to, for cracked concrete for concrete substrates, seismic applications, and for the use in the specific substrate type and characteristics intended. Shop drawings and field sketches shall clearly indicate critical embedment, spacing, and edge distance requirements and placement tolerances determined by the design.

1. For New Concrete Substrates: Attach steel sub-frame to the concrete substrate with embedded anchors per the blast report, but not less than 12 mm diameter x 150 mm headed steel studs, spaced no greater than 300 mm on center. Final sub-frame shop drawings,

product data, and associated delegated design calculations shall be reviewed and approved prior to fabrication and shipment.

2. **[For Masonry Substrates: Provide steel sub-frame, typically a plate, tube, or channel that has a minimum 12-mm thickness for the anchors and a minimum 300 mm width and as determined per the blast design, when blast is a requirement. Post-installed chemical anchors in hollow masonry substrates shall use appropriate screen tubes provided by the anchor system's manufacturer.]**
3. **[For Existing Concrete Substrates: Provide steel sub-frame, typically a plate, tube, or channel that has a minimum 12-mm thickness for the anchors and a minimum depth of the product and as determined per the blast design, when blast is a requirement and in all cases should take into account the existing reinforcing blast.]**

P. [Window replacement and retrofit conditions: When FE/BR window is being replaced in kind, existing embed or subframe may be used if visually assessed to be in good condition and determined by calculation to possess sufficient capacity to meet the specified performance requirements for the window system. It does not need to be replaced solely because it does not meet one of above 12 mm thickness requirements for new sub-frames. Sub-frame design shall provide accommodations for field adjustments to enable installation when verifications in the field prior to fabrication for reinforcing steel or other elements are limited or not feasible. Filling abandoned holes in steel elements with weld material to tap a new hole overlapping the prior hole is not permitted; drilling and tapping a larger diameter hole fully encompassing the smaller hole is permitted, such as in a scenario where the existing threads are damaged or determined to be inadequate for the new connection design. New anchor holes shall satisfy minimum AISC 360 requirements for bolt hole spacing and edge distances. If subframe does require replacement, as determined by OBO/SM, or due to other conditions (e.g., corrosion or size of opening requires modification), then one of new subframe conditions above must be used.]

Q. Factory-Glazed Fabrication: Glaze aluminum windows in the factory. Comply with requirements in Section 088855 "Security Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.

R. Glazing Stops: Provide snap-on or bolted glazing stops coordinated with Section 088855 "Glazing" and glazing system indicated. Provide glazing stops to match frames.

S. Cladding: Cladding shall include any extruded, break metal or otherwise formed component or trim that is applied as a decorative or finish covering of the window frame, mullion, steel frame, trim bars or other components integral to the functional security glazing system.

1. Exterior cladding material: shall be aluminum, stainless steel, or pre-approved composite compatible with the functional security window system.
2. Interior metal cladding or trim: Interior metal cladding shall be aluminum, stainless steel, or pre-approved composite compatible with the functional security window system.
3. Cladding or trim of any type that overlaps security window frame, sub-frame, shim space or ballistic trim bars shall be installed such that the window can be re-glazed without damage to any component or finish of the window system or to the Trim or cladding component, when trim is reinstalled

4. If overlapping material must be removed to re-glaze a window, the material fastening system shall be designed to allow for easy removal and reinstallation without damage to the original overlapping material.

2.5 PROTECTIVE TREATMENT FOR METALS

A. Galvanizing Carbon Steel (hot dip):

1. For shapes, plates, bars and strip: ASTM A123 (2 oz/ft2 minimum coating thickness).
2. For fasteners and hardware: ASTM A153.
3. For sheet: ASTM A653 (G90).
4. For protection against hydrogen embrittlement: ASTM A143.
5. For repair of damage to HDG coatings: ASTM A780.

   a. Acceptable product: ZRC Cold Galvanizing Compound, ZRC Worldwide.

B. Bituminous Paint: SSPC-Paint 12 or ASTM D1187, 762 microns (30 mils) minimum thickness.

C. Surface Protection Film:

1. Colored, strippable PVC film specifically intended for the temporary protection of metal.
2. Film thickness: 76.2 microns (3 mils) minimum

2.6 ALUMINUM FINISHES

A. Coat aluminum extrusions, pressings and similar items prior to assembly.

B. Finish, including color and gloss level, shall be as identified in Construction Drawings. Except where anodic finishes are identified, refer to Section 099602 “High-Performance FE/BR Coatings.”

1. Non-visible components shall be painted per the FE/BR Performance Coating required or may be anodized.

C. [Anodic Finishes:

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
3. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.]

D. No mill finish aluminum is permitted on visible and non-visible components.

E. Match the appearance, color and texture of samples submitted to and approved by the Project Director/COR.

2.7 STEEL FINISHES

A. Carbon Steel (strong-backs and other exposed subframes, connectors, and ballistic trim, etc.):

1. Coat carbon steel shapes and similar items prior to assembly to the maximum extent feasible.
2. Finish, including color and gloss level, shall be as identified in Construction Drawings and Section 099602 “High-Performance FE/BR Coatings.
3. All surfaces of steel members incorporated in the windows shall be finished.
4. If concealed from view, individual and aggregate members shall be hot-dip galvanized as per PROTECTIVE TREATMENT FOR METALS.

5. If exposed to view and connected to exterior elements, individual and aggregate steel members shall be hot-dip galvanized and receive the coating systems as specified in Construction Drawings and Section 099602 “High-Performance FE/BR Coatings.”

B. Stainless Steel:

1. Finish: uniform and free from blemishes, scratches, and other defects.
2. If exposed to view, finish shall be as follows:

   a. [Finish Type SS-1: AISI No. 4 satin directional finish.]
   b. [Finish Type SS-2: AISI No. 4 satin non-directional finish.]

3. If concealed from view, finish shall be AISI No. 2D.
4. Clean and passivate as per the recommendations of ASTM A 380.
5. The grain of all stainless steel and brushed finishes shall run in the long direction for contiguous or adjacent components except where noted on drawings.
6. Touch-up finish in field as required.

2.8 LOW-FRICTION MATERIALS

A. Wherever materials are subject by design to relative movement, provide suitable low friction material(s), such as:

1. Teflon strip, 0.762 mm (0.030 inch) thick; and Teflon tape, 0.127 mm (0.005 inch) thick.
2. High-impact polystyrene or Nylatron equal to Eel-Slip pads as manufactured by Scan-Pac.

B. Low friction materials shall be impervious to moisture.

2.9 SEALANTS AND SEALANT BACKING MATERIAL

A. Structural Glazing Sealant: The following sealants have been shown to be compatible with laminated glazings that include polycarbonates.

1. Neutral cure silicone, medium or high modulus, non-staining, matte finish, color to match the approved sample, and specifically intended for use specified.
2. Multi-component: ASTM C1184; ASTM C920, Type M, Grade NS, Class 12.5.

    a. Acceptable products:

        1) Dowsil 983, Dow Chemical Co.
        2) GE Ultraglaze 4400 or 4600, Momentive Performance Materials.

3. Single-component: ASTM C1184; ASTM C920, Type S, Grade NS, Class 25.

    a. Acceptable products:

        1) Dowsil 995, Dow Chemical Co.
        2) GE Ultraglaze 4000/4000AC, Momentive Performance Materials.

B. Weatherseal Sealant:

1. Neutral cure silicone, low or medium modulus, non-staining, matte finish, custom color to match the approved sample, and specifically intended for use specified.
2. Single-component: ASTM C920, Type S, Grade NS, Class 50, Use A,G, and O.
3. Acceptable products:

    a. Dowsil 795, Dow Chemical Co.
    b. GE Silpruf SCS2000, Momentive Performance Materials.

C. Sealant Backing Materials:

1. Preformed foam plastics and synthetic rubbers, compressible, non-gassing, non-staining, and compatible with sealants and as recommended by sealant manufacturers. Backing shall be of the sizes and shapes to suit the various conditions and shall be a color different than the sealant color. Backer rods shall be 25 percent wider than the joint width.
2. Open/closed cell extruded polyolefin backer rod: ASTM C1330, Type B.
3. Acceptable product: SOF-ROD, Nomaco Inc.
4. Extruded silicone rubber: As specified in the Part 2 Article on PRE-FORMED SYNTHETICS.
5. Cellular glazing tape: As specified in the Part 2 Article on PRE-FORMED SYNTHETICS.
6. Bond Breaker Tape: Lithographer Tape, 3M Company.

2.10 PRE-FORMED SYNTHETICS

A. The particular compound shall be appropriate to the intended function of the preformed synthetic and is subject to approval by the Project Director/COR.

B. Base gasket material manufacturers and gasket extruders are subject to approval by the Project Director/COR.

C. All material shall be non-staining, non-off-gassing, UV stabilized, ozone-resistant, and compatible with glazing edge sealants and polycarbonate.

D. All corners of weatherstripping shall be vulcanized, heat-welded, injection-molded, or otherwise required to form a continuous seal around the panel.

E. Gaskets:

1. Interior closed cell sponge gaskets: silicone gaskets: ASTM C 509, 60 ±5 Shore A durometer.
2. Exterior non-cellular dense wedge gaskets: Non-cellular silicone gaskets: ASTM C 864, 70 ±5 Shore A durometer.
3. Setting blocks:
4. Non-cellular (dense) extruded silicone: ASTM C 1115 Type C, 85 ±5 Shore A durometer, not less than 6mm thick.
5. Spacers, edge blocks, and other profiles:
6. Non-cellular (dense) extruded silicone: ASTM C 1115, 50 to 70 Shore A durometer.

F. Cellular Glazing Tapes:

1. Open cell, semi-rigid, adhesive-backed foam tape.

   a. Acceptable products: Norton Thermalbond V2100, V2200, or Xpress.

2. Closed cell, semi-rigid, adhesive-backed foam tape.

   a. Acceptable products: Norton Norseal V780 or V980.

G. Thermal isolators:

1. Clamped between metal components:

   a. Rigid polyvinylchloride: ASTM D 4216.

2. Integral to extruded aluminum framing: AAMA TIR-A8.

   a. Continuous extruded polyamide 6/6 (Nylon) with 25% glass fiber reinforcement, mechanically crimped to extrusions with knurled cavities. Comply with AAMA QAG-2-12.

      1) Perform shear tests per QAG-2-12. Shear value: Greater than 200 lb/in.

b. Polyurethane poured into a cavity of a single extrusion; dibridged after polyurethane hardens. Polyurethane thermal break systems shall utilize the thermal cavity in accordance with the material manufacturer's recommendations.

3. Provide a continuous thermal break with separation distance as required to comply with specified thermal performance requirements.

H. Weep Hole Filter: PVC-coated reticulated open cell polyurethane foam, 30 to 40 pores per 25.mm (1 inch) in length.

I. Shims: Provide compatible shim material for window frames and adjacent enclosure systems using one of the following:

1. Concealed: Solid PVC, polystyrene, or Nylon
2. Exposed to weather: Stainless steel.

2.11 FLASHING MATERIALS:

A. While General Contractor has overall responsibility for installation of all flashing materials, Manufacturer shall coordinate shop drawings and adjust rough opening and dimensions to accommodate specified flashing below:

B. Metal: Min. 0.607 mm (24 ga.) stainless steel, dead-soft.

C. Pre-Formed Silicone Sheet: ASTM C1518, Movement Class 200, Tear Class PT.

1. Dowsil 123 Silicone Seal, Dow Chemical Co.
2. Ultraspan, Momentive Performance Materials

D. Foil-Faced Polyethylene-Reinforced Self-Adhering Flashing (SAF):

1. Perm-A-Barrier Aluminum, Grace Construction Products
2. HE200AM Metal Clad Weather Barrier, Henry Company
3. Aluma-Flash, Polyguard Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine prepared substrate openings to receive framed fenestration units of this Section. Check anchorages for location and coordination of face plans between walls and fenestration units.

B. Prior to start of installation, inspect the building and verify all conditions and dimensions as being acceptable to receive the Work of this Section.

C. Coat substrate surfaces of concrete, masonry, or steel where they will be in contact or close proximity with aluminum or stainless steel framing of fenestration units. Apply membrane and weather proofing, or a minimum to confined to surfaces which will be concealed.

D. If any conditions are found that may inhibit proper execution of the Work, immediately notify the Project Director/COR in writing. Installation shall not proceed until remedial action, acceptable to the Project Director/COR, has been executed.

3.2 INSTALLATION:

A. Sequencing and Timing Requirements: At the time agreed upon with Project Director/COR, proceed with installation of fabricated aluminum window units in accordance with approved shop drawings, manufacturer's data and instructions, requirements of these specifications and attached Certificate of Compliance. Sequence installation work to achieve proper application for each element indicated, in manner which will produce maximum resistance to indicated forms of attack and weather.

B. Complete any assembly that was not accomplished in the shop. Refer to Part 2 Article on FABRICATION AND ASSEMBLY.

C. Erect the windows, including all snap-on components and accessories, plumb, square, level, and correctly aligned within the following limitations:

1. Offset from true horizontal, vertical, and design location shall not exceed 3.2 mm (1/8 inch) per 3.7 meters (12 feet) nor 12 mm (1/2 inch) over any one length or part thereof the building.
2. Offset from true alignment between abutting components or components separated by less than 75 mm (3 inches) shall not exceed 1.6 mm (1/16 inch).
3. Maximum offset of framing members intersecting at the corner of a glazing cavity shall not exceed 0.80 mm (1/32 inch).
4. Rotation shall not exceed one degree.

D. Joint widths as noted in the Contract Documents are the design joint width at an ambient temperature of 21 deg C (70 deg F). Adjust installation procedures to take into account the ambient temperature at the time of installation.

E. Exercise care to properly brace and reinforce units against racking during hoisting and installation.

F. Anchors and Connections:

1. Avoid cutting rebar during concrete sub-frame installation.
2. Provide 1.6 mm (1/16 inch) thick shims with break-off tabs for rough opening (RO) frame clearance.
3. Match finish of cap plugs used in frame with frame finish to the maximum extent possible. Do not install cap plugs until after the final QA inspection has been completed by either the OBO/CFSM/SM/SCD/SEB or OBO/CFSM/SM FE/BR Program representative

G. Metal Cladding Fastening and Connections shall be mechanically fastened with concealed fasteners or snap-on attachment.

1. Exposed fasteners shall not be permitted. Special cladding attachment conditions that cannot be achieved with concealed fasters may be considered only after formal written application for a specification exception, to include documented engineering proof that concealed fasteners are not achievable, and to include finish detailing of the exception condition.
2. Adhesive fastening of window cladding (trim) in absence of mechanical fastening shall not be permitted.
3. Cladding fastening shall allow for easy removal and re-installation after re-glazing, without damage to any part of the security window system or adjacent construction.
4. Cladding and Trim tolerances: Cladding profiles and fastening shall be designed to remain in place and maintain hairline joint alignment without deformation under positive and negative wind loads indicated in the drawings.

    a. Maximum misalignment of two adjoining members abutting in plane; 79 mm (1/32”)

H. Window Flashing:

1. Sill flashing: Provide stainless steel flashing bedded over membrane water/vapor barrier installed over steel embed. Note that shims shall be placed over stainless steel flashing; do not damage flashing with shim installation.

    a. Sill flashing shall be turned up min. 6 mm (1/4”) on interior side.
    b. Bolt penetrations through flashing, and female receptor nuts, shall be filled with non-hardening liquid sealant or water/vapor barrier compatible to flashing and barrier materials.
    c. Maximum gap (shim space) between top of stainless steel sill flashing and Window frame shall be 6.5 mm (¼”).

        1) The flashing and weather proofing, up to 3 mm, is excluded from calculating the allowable shim space between the embed/subframe and with window frame (i.e. if the flashing and weather proofing combined thickness is equal to 3 mm and the tested shim space was 6 mm, then the allowable space between the embed/subframe would be 9 mm).

    d. Provide weeps in shim space, over stainless steel flashing to allow any water infiltration to drain to the exterior.

2. Jamb and head flashing: Provide liquid or membrane flashing at heads and jambs, providing full cover and protection of steel or concrete window frame/opening. Overlap minimum 4” and seal to top of stainless steel sill flashing to provide continuous flashing around window opening.

I. Corrosion Protection:

1. Ensure by design that no metals, including alloys of the same base metal, are placed together in a manner, combination or location likely to give rise to damage by electrolytic action or other corrosion. Prevent metal to metal contact between aluminum and metals other than an appropriate grade and composition of stainless steel as per the recommendations of the material manufacturer and to the approval of the COR. Ensure that dissimilar aluminum alloys in contact with each other are compatible with each other or isolated. Any other dissimilar materials are to be treated or protected in such a manner as necessary to prevent corrosive action.
2. Isolation of dissimilar metal surfaces to prevent electrolytic action shall be accomplished by materials which are impervious to moisture and non-absorptive.
3. All steel parts shall receive a protective treatment commensurate with their respective functions and locations. The treatment shall be one or more of those described above, and as approved by the COR.
4. Where used to the exterior of air-seals, or in any location vulnerable to moisture, steel shall be hot-dip galvanized after fabrication.
5. Field welds on galvanized steel shall be treated with an approved field cold galvanizing process. Remediation of finish of galvanized steel shall be in accordance with the requirements of ASTM A780 and Sectiond 055005 “METAL FABRICATIONS.”
6. Aluminum surfaces in contact with mortar, concrete, fireproofing, plaster, masonry, or absorptive materials of any kind shall be coated with an anti-galvanic material, impervious to moisture.

3.3 FIELD QUALITY CONTROL FOR THE GENERAL CONTRACTOR/INSTALLATION CONTRACTOR:

A. Inspection: The manufacturer's technical representative shall observe and advise the crew during their installation of the first three FE/BR windows. Upon completion of the installation of each of the three initial FE/BR windows, the manufacturer's technical representative shall inspect the work and direct the crew in any correction or modifications required for acceptable performance of the units.

B. For unique site and design conditions, such as sloped glazing or atrium windows, the manufacturer's technical representative shall also be responsible for observing and inspecting the installation of FE/BR windows, beyond the initial three windows, as necessary to ensure that the installation crew is adequately prepared for installation.

C. Water Leakage Testing:

1. Representative windows shall be field tested for water leakage in accordance with ASTM E1105 (Procedure A):
2. Initial testing shall be performed on each window type shown on the window schedule immediately following approval of the trial installation. Subsequent tests shall be carried out at 30 percent and 60 percent completion of each system. Static pressure differential shall be as specified in the Part 2 Article on PERFORMANCE REQUIREMENTS.

3. At least **[three]** ***<insert number>*** initially successful tests shall be performed on each window type.
4. Test areas shall include perimeter seals to adjacent construction.
5. Test area locations will be designated by the Project Director/COR.
6. An initially successful test shall be defined as one wherein no leakage is observed. If leakage occurs at any point in the test area, the test shall be immediately declared "not initially successful."
7. For each failure condition discovered, make corrective repairs approved by the Project Director/COR and retest until the leakage is eliminated. All failures shall be considered systemic failures requiring corrective work at all similar conditions. Remedial measures shall maintain standards of aesthetics, quality, and durability, and are subject to approval by the Project Director/COR.
8. For each "not initially successful" test, test an additional **[two]** location(s) until an initially successful test is achieved. Additional tests required as a result of initially non-successful tests shall be performed at no cost to the Owner
9. Engage an Independent Testing Agency to perform the tests. Approval of all test areas, test procedures, remediation measures, and test results rests with the Project Director/COR.

D. Sealant Adhesion Testing:

1. Test sealant according to recommendations in ASTM C1521, Destructive Procedure, Method A.

2. Test a minimum of **[four]** locations on each façade.
3. Repair locations damaged by testing.
4. Where Project Director/COR determines that sealant has failed adhesively from testing or does not comply with requirements, additional testing shall be performed to determine extent of non-conforming sealant. Neatly cut out and remove non-conforming sealant, prepare and prime surfaces, and install new sealant. Perform field adhesion tests on new sealant. Additional testing and replacement of non-conforming sealant shall be at Contractor's expense.
5. Document testing with photographs and record results.

3.4 PROTECTION, CLEANING, AND ACCEPTANCE:

A. Protect the windows from any material, equipment or practices that may impair the functioning, appearance or durability of the windows or other construction.

B. Package and store materials in a manner that shall prevent damage, contamination, distortion, breakage or structural weakening.

C. Store pre-glazed units upright or crated and packaged with a rigid protection board on top to prevent damage from ponding of water or by the work of other trades.

D. Do not stage units and related components more than one week in advance of installation in order to avoid damage by other trades. Do not uncrate units more than one day in advance of installation.

E. Replace any material damaged during manufacture, shipping, storage or erection.

F. Protect the installed windows from damage by other trades.

G. Protection materials shall be suitable for the intended protection application and protection period. Do not use materials known to contribute to environmental stress cracking of polycarbonate.

H. Install protection materials in a manner that will not trap harmful moisture or otherwise contaminate the Work in any way.

I. Remove and replace any portion of the windows that has been damaged by other trades. Remove rejected or damaged material promptly from the site.

1. Re-glaze all damaged units per manufacturer's instructions. Install manufacturer provided set screws, 4 per window unit prior to removal of the glazing. Set screws shall be standard socket flat point, ISO 4026, DIN 913. After glass is replaced remove set screws and reinstall all permanent frame anchoring bolts in their original positions.

J. Acceptance of the completed installation of the windows requires the installation be sound, watertight and free from defects of materials and workmanship.

K. Immediately prior to completion of the Work, completely clean the entirety of all windows as follows:

1. Clean all components of the Work as per the recommendations of the specific product manufacturer.
2. Clean the windows from the top most levels down in order to avoid staining of cleaned surfaces from cleaning solution residue and run-off.
3. Clean glass with approved glass cleaning solutions only and ensure that cleaning solution is completely removed from the surface after cleaning. Do not clean glass when it is exposed to direct sunlight.

END OF SECTION 085652

Certificate of Compliance

Aluminum Security Teller Window Assemblies
Teller Window Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the FE/BR products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

	DESCRIPTION – TRAINING & OTHER DUTIES OF TECHNICAL REPRESENTATIVE	
1	The manufacturer's technical representative was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing security teller windows has received training. See requirements for this representative in the Part 1 Article on QUALITY ASSURANCE.	**Representatives Name/Date:**

	DESCRIPTION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	Employees performing the installation meet the specified training and experience qualifications.		
3	Each sub-frame has been installed level, plumb and square.		
4	All sub-frame assemblies shall be factory welded together. Any large sections that exceed the limits of a standard shipping container shall be clearly identified for field welds.		
5	All units have been pre-glazed at the factory.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
6	All temporary fasteners have been replaced with permanent fasteners.		
7	All frame fasteners and threaded openings in subframe have been cleaned of all oil and debris, and have been dry-torqued to meet the manufacturer's specifications. Shims have been inserted at all bolt locations, minimum 1 shim per bolt and maximum as tested condition.		
8	Frame bolts/screws are as shown on the approved shop drawings.		
9	Finish materials do not overlap the window frame/sub-frame or shim space and ballistic trim bars in such a way that the window cannot be re-glazed unless the surrounding finishes and trim are demolished; unless the finish materials can be easily removed and reinstalled. All overlapping finish work (i.e. metal, wood, stone, etc.) can be removed without damaging the window and finish.		
10	Any cladding that covers window glazing stops (angles or tubes) is attached to the frames with hidden fasteners or snap on covers for easy removal.		
11	Any cladding that covers the frame bolt/screw access holes has either access holes with cap plugs or is attached with screws for easy removal. Cap plugs and cladding for each window have been bagged and won't be installed until after the final QA inspection has been conducted by the OBO/CFSM/SMSCD/SEB representative.		
12	Separate pieces of ballistic trim have been installed, as indicated in the approved shop drawings.		
13	Ballistic trim bars have been secured/screwed to the sub-frame and not the window frame		
14	Ballistic trim bars have been installed tight against the window frame, or sill flashing, and gap shall not exceed 2 mm or as tested by the manufacturer.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
15	Maximum gap at shim space shall be no more than then the tested and DS certified assembly, except as noted in the requirements for "Window Flashings" within the Part 3 Article on INSTALLATION.		
16	The manufacturer has provided two metal ID plates for each product that has machine applied letters and numbers (see Part 1 Article on IDENTIFICATION SYSTEMS below).		
17	Deal Tray: Ensure deal tray cover is installed. Ensure no sharp edges.		
18	Deal Drawer: Ensure drawer opens and closes without binding or scraping. Ensure not sharp edges.		
19	Inspect glazing for distortion, defects and/or damage. Defective units, including spall liner damage, do not meet DS certification requirements and must be replaced.		

Installer Team Lead:	**Contractor's QC Manager:**
Printed Name: _____	Printed Name: _____
Signature: _____	Signature: _____
Initials: _____	Initials: _____

Noted Variances:

_____

_____

_____

_____

_____

_____

_____

DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

_____

_____

_____

_____

_____

[1] [2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

SECTION 087135 – NON-SECURITY DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Commercial door hardware other than those included in Security Door Hardware sets.

B. Related Sections:

1. Section 081115 “Hollow Metal Doors and Frames.”
2. Section 081415 “Flush Wood Doors.”
3. Section 087155 “Security Door Hardware” for sets that have been certified by Bureau of Diplomatic Security (DS) and for key management system requirements
4. Division 26 sections for power for electrically operated hardware devices.

1.2 SUBMITTALS

A. Product Data: Submit three copies of catalog cuts of all items used in supplier's schedule.

B. Hardware Schedules: Based upon hardware indicated, organize hardware schedule into groups or sets showing complete designations of every item required for each door opening. Schedule shall be vertical layout. Lines shall be double-spaced with pages numbered and dated. Hardware Sets shall be listed as HW-101, HW-102, etc. with specific function.

1. For doors of different sizes or where hinges, locks or closers are different, a separate heading shall be used. Do not combine labeled openings with non-labeled openings. Horizontal hardware schedules are not acceptable. Include the following:

a. Number, location, hand, fire rating, size and material of each door opening (hands and swings to be determined in relation to key side of opening).
b. Type, style, function, size, finish and quantity of each hardware item.
c. Name and manufacturer of each item.
d. Fastening requirements.
e. Explanation of abbreviations used.
f. Keying information.
g. Wiring diagrams (after each corresponding hardware group).

C. Hardware Schedule Index: Furnish index cross referencing Contract Document door number and hardware group, and supplier's hardware set. Identify in index the page number in submittal where door is shown.

D. Keying Schedule: Submit separate detailed schedule, indicating Government's approved master key system, for Government review and approval after Hardware Schedule has been approved. Keying schedule shall use same numerical order as door schedule and include a column that cross references door numbers in design drawings with final room numbers from signage schedule. Key schedule shall list every door, whether they are keyed or not. Prepare the Key Schedule using Microsoft Excel and submit in electronic formats. Keying information can be sensitive; at no time shall keying schedule be combined with both project number and any form of city/country/location (including abbreviations and airport codes). Do not include city/country/location name fully or abbreviated in the schedule, as a file name, or in the P.O. of the schedule; the schedule shall be identified by the project number only). Key Schedule shall include the following information:

TABLE 1.2
REGISTRY GROUP

Door Number	Final Room Number (Coordinate with signage schedule so that keys for individual doors are properly coordinated with actual room numbers)	Room Description. Indicate From Room to Room.	Key ID Number	Quantity				HW Set	Notes
				Cores	Change Keys	Control Keys	Master Keys		

E. Wiring Diagrams: Furnish wiring diagrams illustrating point-to-point hook-up of all electrical hardware specified herein. Include fire alarm and/or access control system interface where applicable. Diagrams shall be complete by opening and shall indicate connections between all components affected. Manufacturers' standard line diagrams are not acceptable.

F. Shop Drawings:

1. Stand-Alone Key Cabinets: Include partial plans, partial elevations, wall sections, details, and attachments to other work. Indicate required clearances, method of field assembly, components, and location and size of each field connection. Indicate weight capacity of cabinet, and indicate organization method of keys.

G. Seismic Calculations: Where seismic stability is required by OBO adopted code provisions, submit calculations showing ability of door systems to withstand pertinent seismic forces.

H. Samples: If requested by Project Director/COR, submit one sample of each requested item tagged with full description for coordination with hardware schedule. These items will remain on file in Project Director/COR's office until all other similar items have been installed in project. At that time, items on file will be released for installation in pre-determined Project locations.

I. Installation Certification: After completion of hardware installation, submit written certification attesting that hardware has been installed in accordance with manufacturer's templates and instructions and that hardware has not been altered.

J. Operating Instructions: Furnish Government with one complete set of installation instructions, including special adjusting tools and maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Furnish one complete catalog for each manufacturer listed in approved hardware schedule.

K. Templates: Furnish templates and approved hardware schedule to door and frame fabricators. Where fabricator cannot work to paper templates, ship templates and/or physical hardware to factories of respective manufacturers. Prepay cost for shipping and delivery.

L. Informational Submittals: Submit the following:

1. Certifications as required in Article on QUALITY ASSURANCE.
2. Qualifications Data: Hardware Suppliers Qualification data.

M. Closeout Submittals: Submit specified warranty in accordance with Division 01 requirements.

1.3 QUALITY ASSURANCE

A. General Requirements: Hardware has been specified by manufacturer's name, brand and catalog numbers for purpose of establishing basis for quality, design and operational function.

1. Except where specifically indicated otherwise (i.e., LCN, Von Duprin - no substitution), equivalent products from other listed manufacturers are also acceptable.
2. Provide designated product, or where more than one product or manufacturer is listed, provide equivalent product of one of other listed manufacturers.
3. Obtain each type of hardware from single manufacturer.
4. Hardware Sets within this Section are not complete with respect to thickness of doors, hand, backset, method of fastening, and other detail requirements.
5. Review Drawings and Door Schedules thoroughly and provide required hardware for all openings, including openings that may have been inadvertently omitted from Door Schedules.

6. Should opening be omitted or opening not indicated with hardware set, provide hardware of same quality, design and function as specified for similar openings.
7. Furnish hardware complete with brackets, plates, fittings, fastenings and other accessories required for installation.

B. Regulatory Requirements:

1. Comply with requirements of Chapter 11 of the OBO Building Code as applicable to accommodate barrier free design.
2. Provide knurled tactile warning on door hardware to hazardous areas; abrasive coating not acceptable.
3. Comply with NFPA 80 for hardware at fire-rated assemblies.
4. Provide hardware that has been tested and listed by UL or FM for fire-rated assemblies of types that comply with requirements of door and frame labels.

C. Hardware Supplier Qualifications: Door hardware supplier who has been furnishing hardware for period of not less than five years, and who is, or who employs an Architectural Hardware Consultant (AHC), who has facility clearance, and who will be available at reasonable times during course of Work for consultation about Project's hardware requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Pack each hardware item separately. Include manufacturer's printed installation instructions, trim, fasteners accessories, and special tools necessary for installation.

B. Legibly mark and adequately label each package indicating opening for which intended. Provide markings corresponding with approved Hardware Schedule.

C. Deliver permanent security cores and keys as indicated in Keying section, not less than two months prior to scheduled substantial completion.

PART 2 - PRODUCTS

2.1 HINGES

A. Acceptable Manufacturers:

1. Bommer Industries.
2. Hager Companies.
3. McKinney.
4. Stanley Hardware.

B. Butt Hinges: Five knuckle design with square corners.

1. Full mortise type. (Heavyweight, Stainless Steel - ANSI A5111).
2. Flat button tip and matching plug.
3. Non-removable pins for out-swing exterior doors and for interior reverse bevel doors equipped with locking; safety stud is not acceptable**.** Non-rising pin for other doors.
4. Non-ferrous construction at all locations (interior and exterior).
5. Anti-friction bearings may be furnished in lieu of ball bearings, except where prohibited on fire doors by the requirements of NFPA 80.

C. Minimum Number Hinges:

1. Furnish two hinges for doors 1520 mm (60 inches) or less in height and one additional hinge for each additional 760 mm (30 inches) of height or fraction thereof.

D. Minimum Size:

1. Unless otherwise specified, hinges for doors through 914 mm (36-inches) wide shall be 115 by 115 mm (4-1/2 by 4-1/2 inch); hinges for doors over 914 mm (36-inches) wide shall be 127 by 115 mm (5 by 4-1/2 inch).

2.2 MECHANICAL LOCKS, LATCHES, AND DEADLOCKS

A. Acceptable Manufacturers:

1. Corbin Russwin Architectural Hardware. (no substitutions).

B. Description: Mortise locks and latches shall be equal to Corbin Russwin ML2200 Series with NSM trim.

1. Levers shall be cast or solid metal.
2. All internal working parts of the lock shall be brass bronze, steel or stainless steel.
3. For each lock and latch set, provide strike box and square corner ASA strike with curved lips of sufficient length to protect frames.

2.3 PUSHBUTTON LOCKS

A. Application: See parameters chart at end of specification section.

B. Acceptable Manufacturers:

1. Simplex Access Controls: KABA Simplex L1021C-26D-41, prepared for Corbin Russwin cores (no substitutions).

C. Trim: Furnish units complete with lever handle trim and ASA strikes.

1. Finish matching lock.

D. Strike: ASA 124 mm (4-7/8-inches)

1. Equip with wrought box.
2. Finish matching lock.

2.4 EXIT DEVICES AND EXIT DEVICE ACCESSORIES

A. Acceptable Manufacturers: No Substitutions:

1. Von Duprin, Inc.

B. Description:

1. Use Von Duprin 99-series devices.
2. Devices shall use lever operation except for Exit Only applications (and associated door side).

2.5 CYLINDERS AND CORES

A. Provide cylinders for locks, deadlocks, and other control and locking devices.

B. Doors:

1. Acceptable Manufacturer:

a. Corbin Russwin Architectural Hardware (no substitutions).
b. Use of Medeco cylinders is not permitted for non-security hardware sets at buildings; see Section 087155 “Security Hardware” for use of Medeco cylinders at buildings.
c. The use of restricted or reserved keyways is prohibited. If established, the use of a Department of State reserved keyway is allowed.

2. Description:

a. Cylinders shall be minimum six-pin keyway with large format interchangeable cores. Small format interchangeable cores are prohibited.
b. Equip cylinders with temporary construction core for use during construction.

3. Description:

a. Original high security cylinder with interchangeable core. Provide six-pin commercial keyway.
b. Equip cylinders with temporary construction core for use during construction.

C. Hardware for Wire Mesh Partitions (e.g., separating tenant storage in Warehouse): Corbin Russwin 4011 cylinder outside, blank inside; all other hardware by wire mesh partition manufacturer.

D. Permanent Cores: Contractor shall use only OBO project numbers for transmitting permanent locks. Do not identify by project name or location. Refer to Article on KEYING.

2.6 CLOSERS

A. Manufacturers: Basis of Design:

1. LCN 4040XP Series Closers

B. Features required for all closers:

1. Closers shall comply with ANSI/BHMI A156.4-2024 Grade 1
2. Manufacturer's standard cast iron construction.
3. Rack and pinion construction with compression spring, fully hydraulic.
4. Closing speed and latching speed controlled by independent valves.
5. Adjustable spring power allowing adjustment up to 50 percent in field to suit individual door conditions.
6. Adjustable hydraulic backcheck.
7. Furnish with necessary arms, track, brackets, plates, shoe, and other accessories to suit door and frame conditions.

C. Additional features specific to individual doors:

1. Provide non-sized, surface, or concealed mounted as scheduled, or as otherwise appropriate for each door.
2. Parallel Arm Closers: Where parallel arm closers are required, furnish manufacturer's extra-heavy duty arm.
3. Surface Closers: Provide manufacturer's standard non-metallic cover. Locate on the least conspicuous side of the door (side opposite public view).
4. Built-In Stops: Where door closers are used, and wall stops are not suitable, provide closer arms with built-in stops.
5. Hold open and dead stop features as scheduled or as otherwise appropriate for individual doors.
6. Provide manufacturer’s special rust inhibiting finish on closers exposed to elements.

2.7 AUXILIARY HARDWARE

A. Acceptable Manufacturers:

1. Hager Companies.
2. Ives.
3. Rockwood Manufacturing Co., Inc.
4. Triangle Brass Manufacturing Co., Inc.

B. Manual Flush Bolts: Top manual flush bolt shall not exceed 1880 mm (74-inches) from floor to centerline.

C. Wall Stops: Furnish wall stops wherever trim strikes wall.

1. Basis of Design: Rockwood 400.
2. Where wall stops are not suitable, see Article on OVERHEAD STOPS AND HOLDERS.
3. Where door closers are used, and wall stops are not suitable, provide closer arms with built-in stops; see Article on CLOSERS.

D. Silencers: Furnish rubber silencers for hollow metal frames; three per single door and four per pair. Silencers are not required at doors specified to receive continuous weather-stripping or seals.

1. Basis of Design: Rockwood 6008.

2.8 ARCHITECTURAL DOOR TRIM

A. Acceptable Manufacturers:

1. Builder's Brass Works Corp.
2. Hager Companies.
3. Rockwood Manufacturing Co.
4. Triangle Brass Manufacturing Co.

B. Protection Plates: Kick and armor plates shall be beveled on all sides, equal to Hager Companies 194S Series.

1. Size: Unless otherwise indicated or where narrow bottom rails dictate smaller size, kick plates shall be 250 mm (10-inches) high and armor plates shall be 865 mm (34-inches) high by 400 mm (16-inches) high on fire rated doors. Width shall be 40 mm (1-1/2-inches) less than the door width on single doors and 25 mm (1-inch) less than door width on double doors.
2. Factory-prepare flat goods for conflicting hardware (e.g. lever handles, cylinders, turn pieces, etc.) as required.

C. Push and pull plates shall be 150 mm by 400 mm (6 by 16 inches).

D. Fasteners: Flat goods shall be furnished with Phillips undercut, countersunk screws per ANSI A156.6. Trusshead screws are not acceptable.

2.9 OVERHEAD STOPS AND HOLDERS

A. Acceptable Manufacturers:

1. Architectural Builders Hardware.
2. *Glynn-Johnson.
3. Rixson.

B. Where wall stops will not work, furnish surface overhead stops.

1. Basis of Design: Glynn-Johnson 450 Series.

C. In hardware sets where door closers are scheduled, provide closer arms with built-in stops; see Article on CLOSERS.

2.10 THRESHOLDS, ASTRAGALS, WEATHER-STRIPPING, AND SMOKE SEALS

A. Acceptable Manufacturers:

1. Hager Companies.
2. National Guard Products.
3. Pemko.
4. Reese Enterprises.
5. Zero International.

B. Threshholds: Where required, field modify thresholds to accept strikes for flush bolts and exit device rods.

1. Basis of Design: Pemko 2005AT for accessible door with exit device.

C. Astragals: Astragals shall be full height, installed on "threat" side of opening.

1. Basis of Design (selected for application): Pemko 357, Pemko 18041.

D. Weatherstripping:

1. Basis of Design: Pemko 332CR.

E. Smoke Seals: Where required by OBO adopted model code, at doors located in Smoke Barrier Partitions, provide smoke seals, and coordinate Drawings and associated schedules. Basis of Design as follows:

1. Single Doors: Pemko S88 at head and jambs.
2. Pairs of Doors: One Pemko 375CR or two Pemko 303AS astragal seals as appropriate.

2.11 GENERAL SOUND PROTECTION

A. Provide full door gasketing/acoustical seals and automatic door bottoms where required in OBO Building Code Chapter 12 for sound protection.

B. Basis of Design:

1. Sound Seals: Pemko S88.
2. Automatic Door Bottom: Pemko 430CMPKL.

2.12 ACCESSORIES

A. Door Coat and Hat Hook: Provide cast aluminum, double prong hooks on inside face of all toilet rooms; ANSI/BHMA A156.16, L33113.

1. Basis of Design: Ives Model No. 405 wide body design.

B. Door Coat and Hat Hook: Provide polished chrome double prong hook on inside face of all private office doors; ANSI/BHMA A156.16, L33113.

1. Basis of Design: Mockett Model CH11 Longhorn Coat Hook.

2.13 KEY CONTROL SYSTEM

A. Stand-Alone Key Cabinets: Provide Global Industries Steelmaster Unitag 200 key (2019200D03) wall-mounted non-recessed key cabinet with dual control system including envelopes, labels, tags with self-locking clips, receipt forms, three-way visible card index, temporary markers, and permanent markers. And metal cabinet. Equip cabinet with pin tumbler locking mechanism.

1. General Services Office (GSO): Provide capacity for storing **[200]** key sets.
2. Facility Management (FM) Office: Provide capacity for storing **[100]** keys.

2.14 KEYING

A. Development of keying schedule may require facility clearance to access complete room schedule where classified access controls are involved. In these cases, handle documents in accordance with Industrial Security Act.

B. Reference and mark keying schedules using only OBO project number.

C. The following is Government recommended keying plan for NON-SECURE DOOR OPENINGS:

1. No keying should be done to a master key or grand master key system. To explain this requirement, no one MASTER KEY should operate a complete building or no one GRAND MASTER KEY should operate a group of buildings at post or site.
2. Buildings should be Master Keyed by floor.
3. Each of the following individual areas can utilize KEYED-ALIKE SETS and be passed by floor master (e.g., all of Mechanical Rooms from basement to penthouse should be keyed alike to a set, and be passed by individual floor Master Key):

    a. Mechanical Rooms.
    b. Electrical Rooms.
    c. Janitor Closets.
    d. Toilet Rooms.
    e. Telephone Rooms.
    f. Stair Wells.
    g. Kitchen Areas.

4. This system allows roving marine, who is carrying each of Floor Master Keys, access to any of these rooms on each floor.
5. Authorized personnel for any of individual keyed alike-set area carrying their keyed-alike set key should be able to open their area on any floor, and not open any other area. No other area keyed-alike set key should open any other area.
6. Tenant Areas should utilize keyed different sets and be passed by floor master.
7. Special storage areas and cashiers offices should be single keyed different (SKD), with no master key. This protects integrity of persons who have responsibility of these type areas.
8. Single office space shall be keyed different and passed by floor master key. If there is more than one entrance door into an office, these doors should be keyed alike, and passed by floor master key.

D. Project Director/COR, General Contractor, and post representative identified by Regional Security Officer (RSO) or Post Security Officer (PSO) shall meet to determine if there are any special keying conditions required so they may be incorporated into keying schedule.

E. Key Quantities : Furnish plain bow keys of nickel silver material in the following quantities:

1. For each master key system, provide:

    a. Two master keys.
    b. Two control keys (pinned to the master).
    c. Two operating keys per cylinder change.

2. For each individually keyed cylinder, provide:

    a. Two control keys.
    b. Two operating keys per keyed cylinder.

3. For each construction key system, provide:

a. Two control keys.
b. Eight master keys.

F. Identification and Control

1. Identify master keys with registry number; do not stamp with “master key,” letter “M,” or similar identification; manufacturer's trademark or identification not allowed.
2. Stamp master keys with DO NOT DUPLICATE.
3. Furnish visual controls system; coordinate provisions with Government. Stamp or emboss keys and cylinders with identification code.

G. Delivery of Cores, Keys and Cylinders:

1. Deliver construction cores, construction master keys, and construction key to the U.S. Department of State at the following address:

Diplomatic Security Lock Program
5800 Barclay Drive, Suite 5
Alexandria, VA 22315

2. Permanent cores, operating keys, and permanent control keys shall be individually packaged by door, identified by lock. Contact Project Director/COR to identify U.S. Government location for receiving shipment of these items from supplier via prepaid freight.
3. Clearly mark shipping boxes with OBO Project and Purchase Order numbers only. Pinning, bitting and keying schedules are required for all prepared systems.
4. After removal of temporary construction cores, ship construction cores, construction keys, and construction control keys to address above.

H. Delivery of Keying, Pinning, and Bitting Schedules

1. Keying, Pinning, and bitting schedules shall be provided for all non-security door hardware to:

Diplomatic Security Lock Program
5800 Barclay Drive, Suite 5
Alexandria, VA 22315

2.15 FINISHES

A. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturers' standard metal alloy of composition, temper and hardness, but in no case of lesser quality than specified or inferred by use of particular manufacturer's number, style or grade or as established by appropriate referenced specification listed herein.

B. Finishes: Finishes shall conform to quality of finish including thickness of plating or coating (if any), composition, hardness and other qualities complying with manufacturers' standards, but in no case less than standards established by ANSI/BHMA A156.18.

1. All exposed hardware except door closers shall be satin stainless steel, ANSI/BHMA 630/US32D. Hinges shall be satin stainless steel.
2. Furnish items not available in stainless steel with satin chrome finish, ANSI/BHMA 626/US26D.
3. Paint closers, astragals, and brackets to match satin stainless steel.
4. Match non-security hardware finish with security hardware finish in Section 087155 “Security Door Hardware” to maximum extent possible.

C. Prime Coated Items: Field paint in accordance with Division 09 painting sections.

2.16 FASTENERS

A. Manufacture hardware shall conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping or sheet metal screws except as specifically indicated.

1. Furnish screws for installation with each hardware item. Provide Phillips flat head or oval head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces of other work, to match finish of such work as closely as possible, except as otherwise indicated.
2. Provide concealed fasteners for hardware units that are exposed when the door is closed, except to extent no standard manufactured units of type specified are available with concealed fasteners.
3. Do not use through bolts for installation except where it is not possible to adequately reinforce work, to accept machine screws or concealed fasteners or other standard type, to satisfactory avoid use of through bolts. Grommet nuts and cealnuts are not acceptable.

B. Furnish fasteners that are compatible with both units fastened and substrates, and which will not cause corrosion or deterioration of hardware, base material reinforcement, or fastener. Furnish wall stops with expansion anchors and machine screws. Furnish thresholds with lead anchors and 1/4-20 stainless steel machine screws.

2.17 ACCESSORIES

A. Door Coat and Hat Hook: Provide cast aluminum, double prong hooks on inside face of all private office doors and toilet rooms; Ives Model No. 405 wide body design (ANSI/BHMA A156.16, L33113).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install hardware plumb, level, and true to line in accordance with manufacturer's templates, and Project conditions.

1. Install fire rated hardware in accordance with NFPA 80.
2. Where cutting and fitting is required on substrates to be field painted or similarly finished, install, fit, remove and store hardware prior to finishing. Reinstall hardware after finishing operations are completed.
3. Do not install surface mounted items until finishes have been completed on the substrate.
4. Reinforce attachment substrates as necessary for installation and operation.
5. For substrates which are not factory prepared for hardware:
6. Mortise work to correct size and location without gouging, splintering or causing irregularities in exposed finish work.
7. Fit faces of mortised components snug and flush without excessive clearance.
8. Set thresholds at exterior doors in bed of sealant. Remove excess sealant.

B. Hardware Mounting Heights: Mount hardware units at heights recommended by DHI (see "Recommended Locations for Builders Hardware") on custom doors except as otherwise indicated or required to comply with governing regulations, and except as otherwise indicated.

C. Cylinder Cores: When instructed, Contractor shall remove temporary construction cores. Permanent cores will be installed by Government. Refer to Article on KEYING for requirements, after installation of permanent cores, regarding shipment of construction cores, operating keys, and control keys.

D. Power-Assist Operators: Where post mounted actuator buttons are indicated, run signal wire below grade in conduit complying with requirements in Division 26 sections. Run pneumatic lines between pumps and door operators concealed. At curtain walls, run pneumatic lines concealed in metal trays finished to match curtain wall.

E. Stand-Alone Key Control Cabinets: Surface mount units on wall.

3.3 ADJUSTING

A. Check and adjust each operating hardware item to ensure correct operation and function.

1. As applicable, adjust hardware to comply with accessibility requirements of Chapter 11 of the OBO Building Code for operating time and maximum opening force.
2. Ensure weather-stripping and seals do not inhibit closing and positive latching of door.
3. Lubricate moving or operating components as recommended by hardware manufacturer. Use graphite type lubrication if none other is recommended.
4. Replace defective materials or units that cannot be adjusted to operate as intended. Reinstall items found improperly installed.
5. Prior to date of Substantial Completion, readjust and reapply lubricant to hardware items as necessary.

3.4 DEMONSTRATION

A. Instruct Government's designated personnel in proper adjustment and maintenance of hardware at time of Substantial Completion.

1. In presence of Government's representative, demonstrate that keys operate freely in designated unit.
2. Hardware supplier: Completely set-up key control system for hardware associated with the Section, with keys tagged and placed in cabinet, cross index system executed with appropriate information typed in on index cards. Instruct Government's designated personnel in proper use of system.

3.5 HARDWARE SETS

QUAN.	ITEM	BASIS OF DESIGN	NOTES	FIN.
HW-101 – (Insert Lock Function (e.g. Passage, Privacy, Storeroom) next to Set I.D.)				
	Hinges	FBB199		630
1	Latch	ML2010	NSM	630
1	Closer	4041		689
1	Kick Plate	194S		630
1	Stop	A/R		626

END OF SECTION 087135

ILLUSTRATIVE PARAMETERS FOR LOCK FUNCTIONS
IN NON-SECURITY HARDWARE SETS

The following lists are partial and illustrative, and address door function only for non-security hardware sets. These functions and the functions for other doors shall be confirmed/identified with input from OBO. For security hardware sets (SHW), see OBO standard specification section 087155.

MARINE SECURITY GUARD RESIDENCE (MSGR)

SPACE NAME	DOOR FUNCTION
Closet, Entry	Passage
Living Room	Passage
Closet, Living Room	Passage
Recreation Room	Open
Dining Room	Open
Heritage Room	Open
Storage, Heritage Room	Push Button
Kitchen	Passage
Pantry	Passage
Food Storage	Push Button
Restroom – Public	Privacy w/ Indicator
Laundry	Passage
Linen	Passage
Exercise Room	Passage
Breakroom Staff	Passage
Breakroom Bathroom	Privacy
Bedroom	Apartment
Bathroom – Ensuite	Privacy
Janitors Closet	Passage
Corridor (Separating Public from Sleeping Rooms)	Check SHW
Exterior Doors, including Roof Access	Check SHW
Emergency Residential Response Room	Check SHW
Mechanical Room	Check SHW

Electrical, EC, and Telephone Rooms	Check SHW

SUPPORT ANNEX BUILDING/ SHOPS

SPACE NAME	DOOR FUNCTION
Change and Locker Rooms	Passage
Breakroom *(when not used as a Compound Emergency Sanctuary)*	Passage
Laundry	Passage
Facility Management Materials Storage	Storeroom
HVAC and Electrical*	Storeroom/Classroom
Carpentry*	Storeroom/Classroom
Paint Shop*	Storeroom/Classroom
Plumbing and Appliance Repair*	Storeroom/Classroom
Welding, Indoor	Classroom
Welding, Outdoor	Storeroom
Multipurpose Shop*	Storeroom/Classroom
Facility Management Lockable Storage	Storeroom
Grounds Maintenance Equipment and Storage	Storeroom
Vehicle Maintenance Bay	Storeroom
Vehicle Maintenance Storage	Storeroom
Restroom – Single Occupant	Privacy w/ Indicator

*Where shops have exterior and interior access, the interior doors shall be equipped with classroom lockset and the exterior doors shall be equipped with storeroom lockset. Where shops only have exterior access, doors shall be equipped with storeroom lockset. Where shops only have interior access, doors shall be equipped with classroom lockset.

WAREHOUSE BUILDING

SPACE NAME	DOOR FUNCTION
Building Entrance *(when entry is into shared corridor)*	Push Button
Telecom Service Entrance Facility	Check SHW
Sub-EC Room	Check SHW
Storage, Archives Long Term	Storeroom
Storage, Residential General Purpose	Push Button
Storage, Expendable Supplies	Storeroom
Non-Standard Space, Storage	Storeroom
Storage, Agency Cage	Storeroom
Storage, Forklift Battery Charging Station	Open
Storage, Remote Emergency Medical	Storeroom
Storage Expendable, Environmental Security Supplies	Storeroom
Loading Dock and Canopy	Open (Exterior)
Storage, RSO	Storeroom
Storage, Welcome Kits	Classroom
Storage, Receiving Area	Push Button
Storage, Residences CMR and DCR	Storeroom
Storage, Maintenance Supplies	Storeroom

UTILITY BUILDING

SPACE NAME	DOOR FUNCTION
Fire Pump Room	Storeroom
Fuel Oil Control Panel	Storeroom
Generator	Check SHW
Switchgear, Utility Building	Storeroom
Domestic Water Treatment	Storeroom
Fuel Day Tank Storage	Storeroom
Water Treatment Testing Lab	Storeroom
Telephone Room	Check SHW
Sub-EC Room	Check SHW

NEW OFFICE BUILDING

SPACE NAME	DOOR FUNCTION
Breakroom *(when located within GWA)*	Passage
Breakroom *(when accessed from exterior)*	Check SHW
Pantry	Passage
Pantry, Multipurpose Room	Passage
Hub	Open
Janitors Closet	Storeroom
Trash Recycle Room	Passage
Mechanical Room	Check SHW
Food Service, Servery	Varies*
Food Service, Preparation and Cooking	Passage
Food Service, Potwashing	Open
Food Service, Warewashing	Open
Food Service, Refrigerator Room	Passage
Food Service, Dry Storage	Passage
Food Service, Soiled Tray Drop	Open
Food Service, Refrigerator Machinery Room	Storeroom
Food Service, Employee Locker	Passage
Conference Rooms *(Non-CAA)*	Passage
Multipurpose Room *(from Main Lobby)*	Check SHW
Multipurpose Room *(to GWA)*	Check SHW
Multipurpose Room *(to shared corridor leading to support spaces)*	Passage
Classroom, Language Instruction	Passage
Library	Open
Team Room	Passage
Focus Room	Passage
Community Room	Passage
Ablution Wash Area	Passage
Gallery	Open
Interview Room	Check SHW

Education USA Advising Space	Passage
Healthcare, Phlebotomy Alcove	Open
Healthcare, Lab	Passage
Healthcare, Restroom	Privacy w/ Indicator
Healthcare, Storage	Push Button
Healthcare, Pharmacy	Check SHW
Healthcare, Wellness Room	Passage
Healthcare, Exam Room	Passage
Healthcare, Waiting Area	Check SHW
Healthcare, Observation Room	Passage
Healthcare, Reception	Open
Healthcare, Nurse Workstation	Open
Healthcare, Filing and Charts	Push Button
Healthcare, Laundry Closet	Passage
Healthcare, Consultation Room	Passage
Healthcare, Isolation Room	Passage
Lactation Room	Privacy w/ Indicator
Building Automation Systems Room	Push Button
Technical Workshop	Check SHW
EC Room	Check SHW
Joint Unclassified Computer Room	Check SHW
Main Terminal Space	Check SHW
Radio Network Equipment Room	Check SHW
Telecommunications Room	Check SHW
Telecom Service Entrance Facility	Check SHW
Translation Booth	Passage
Main Telephone Equipment Room (PBX)	Check SHW
AV Control Booth	Passage
Radio or Telephone Workshop	Check SHW
EAP Equipment Racks	Check SHW
Equipment Room Consular Affairs	Push Button

Mail Room	Check SHW
Diplomatic Post Office Service Center	Push Button
Office, Commercial Travel	Passage
Office, GWA	Passage
Office, Executive	Passage
Office, Within CAA Restricted Office Suite	Passage
Office, Within LAA Office Suite	Passage
Office, CAA CORE	Check Project Technical Requirements
Exercise Room	Passage
Aerobics Studio	Passage
Change and Locker Room	Passage
Restroom, Multiple Occupants	Passage
Restroom, Executive	Privacy
Restroom, Unisex Accessible (Single Occupant)	Privacy w/ Indicator
Post 1 / Post 2	Check SHW
Guard Booth	Check SHW
Pouch Vault	Check SHW
Storage, Vault	Check SHW
Storage, Controlled	Check SHW
Commissary Stock Room	Push Button
Commercial Bank	Check SHW
Cashier Booth	Check SHW
Privacy Booth, Applicant	Passage
Privacy Booth, Window	Passage
Consular Cashier Service, Window	Check SHW
Commissary Sales Room	Push Button
Fax Room	Passage
CLO Reference Meeting Area	Passage
Computer Training Room	Check SHW

React Room	Check SHW
Workroom	Passage
Reproduction	Check SHW
ID Photo (Picture) Room	Check SHW
Workroom, Facilities Computer	Push Button
Workroom, MSG Co-Lateral Duties	Check SHW
Workroom, AV Media	Push Button
Workroom and Pantry Combination	Passage
CAA Restricted and CAA Core Suites	Check SHW and Project Technical Requirements

*Where serveries include multiple doors and/or large overhead/sliding doors, provide adequate hardware to lock food service areas during off-business hours while allowing for open access during business hours.

RECREATION BUILDING/CABANA

SPACE NAME	DOOR FUNCTION
Janitor Closet	Passage
Restroom – Single Occupant	Privacy w/ Indicator
Change and Locker Rooms	Passage
Change Room, Family	Privacy w/ Indicator
Storage, Pool Chemicals	Storeroom
Storage, General	Storeroom
Trash Recycle Room	Passage
Pool Equipment Room	Storeroom

REPRESENTATIONAL RESIDENTIAL SPACES

SPACE NAME	DOOR FUNCTION
Bathroom	Privacy
Bedroom	Privacy
Toilet, Accessible (Public Access and Single Occupant)	Privacy w/ Indicator
Break Room	Passage
Lounge, Bodyguards/Drivers	Passage
Trash Room	Passage
Mechanical Room/Closet	Storeroom
Electrical Room	Storeroom
Pool Pump Room	Storeroom
Telephone/Data Room	Storeroom
Demarcation Room	Storeroom
Dressing Room	Passage
Closet	Passage
Foyer	Check SHW
Utility Room	Passage
Garage	Apartment
Formal Hall or Stair	Open
Service Entrance (Exterior)	Check SHW
Dining Room	Open
Wet Bar	Open
Gym	Passage
Library	Privacy
Parlor	Open
Reception Room	Open
Laundry Room	Passage
Salon	Open
Living Room	Open
Sitting Room, Bedroom	Privacy
Study	Privacy

Office, Chef	Office
Office, House Manager	Office
Kitchen, Family	Open
Service Pantry	Passage
Kitchen, Commercial	Passage
Restroom, Single Occupant	Privacy w/Indicator
Restroom, Multiple Occupants	Passage
Poolside Changing Room (Multiple Occupants)	Passage
Locker Room, Staff 1	Privacy w/Indicator
Locker Room, Staff 2	Passage
Locker Room, Staff 2 Toilet Stall	Privacy w/Indicator
Locker Room, Staff 3	Passage
Locker Room, Staff 3 Toilet Stall	Privacy w/Indicator
Powder Room	Passage
Toilet, Staff	Privacy w/Indicator
Storage, Food	Storeroom
Refrigerator Room	Storeroom
Storage, Pool	Storeroom
Storage, Table and Chair	Storeroom
Storage, Family	Storeroom
Storage, Linen	Storeroom
Storage, Beverage	Storeroom
Storage, Dry Storage	Storeroom
Storage, Garage	Storeroom
Storage, Garden	Storeroom
Storage, General	Storeroom
Storage, Representational Supplies	Storeroom
Storage, Maintenance Closet	Storeroom
Storage, Wet Bar	Storeroom
Storage, Cabana	Storeroom
Storage, Pool	Storeroom
Storage, Table and Chair	Storeroom

SECTION 087155 - SECURITY DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes door hardware associated with security door hardware sets that have been certified by the Bureau of Diplomatic Security (DS).

B. Related Sections

1. Section 013305 “Construction Submittals.”
2. Section 017825 “Operation and Maintenance Data” for digital format requirements.
3. Section 083454 “FE/BR Door Assemblies.”
4. Division 08 Section for other openings and frames were identified as using security door hardware in schedule(s) within Construction Documents.
5. Section 087135 “Non-Security Door Hardware.”
6. Division 26 and 28 for electronic security and power for electrically operated hardware devices.
7. Section 337105 “Underground Ducts and Raceways” for manhole/handhole lock requirements.

1.2 SUBMITTALS

A. General: Submit in accordance with Division 01 requirements.

1. All submittals under this Section shall be submitted as PDF’s conforming to the Digital Formatting requirements of Section 017825 “Operation and Maintenance Data,” except as noted. Refer to “Adobe XI Pro Accessibility Guide” from Adobe Systems Inc. for implementation guidance of PDF.

   a. The Binder PDF shall be “Bookmarked” to identify each different “Submittal Types” within the “Binder” PDF, and to identify sub-divisions within respective Submittal Types
   b. Appropriate “Shop Drawing (SDx)” submittals shall contain “Bookmarks” and “Hyperlinks” that easily provide access to “Product Data (PDx)” and other “Submittal Types”, within the “Binder” PDF.
   c. Failure to provide a “Binder” PDF containing “Bookmarks” and “Hyperlinks” shall be basis for rejecting submittals requiring concurrent submittal reviews.
   d. Contractor shall also use “Reduced Size” saving process when finalizing the PDF for submission. This has the following advantages:

      1) Minimizes the ProjNet upload and download time
      2) Maximizes navigation performance within the document.
      3) Minimizes the document size for hard drive storage.

B. Product Data: Submittals (PDx format):

1. Manufacturer's Catalog Data (PD1): This submittal shall be major part of a concurrent review with Standard Color Charts (PD2), appropriate Shop Drawing (SDx) submittals listed below.
2. Submit original PDF files downloaded from the vendor websites, to include the following: catalog cuts; brochures; construction and installation details; material descriptions, dimensions of individual components, profiles; finishes; Submit copies of catalog cuts of all items used in the supplier's schedule in PDF format; submittals of scans are not acceptable.
3. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: For power door operators. Include plans, elevations, sections, details, and attachments to other work.

1. Indicate required clearances, method of field assembly, components, and location and size of each field connection.
2. Include locations and elevations of entrances showing activation and safety devices.
3. Key Control Accessories: Include plans, elevations, sections, details, and attachments to other work. Indicate required clearances, method of field assembly, components, and location and size of each field connection. Include weight capacity of drawer and indicate organization method of keys.

D. Hardware Schedules: Based on hardware indicated, organize hardware schedule into groups or sets showing complete designations of every item required for each door opening. Schedule shall be vertical layout similar to format used herein. Lines shall be double-spaced with pages numbered and dated; Security Hardware Sets shall be listed as SHW-1, SHW-2, etc. Hardware schedules shall be submitted as a complete schedule for entire project and shall include forced entry rated door and non-forced entry rated doors and all outbuildings, except for projects with multiple office buildings or phases, as noted in the Part 2 Article on KEYING.

1. For doors of different sizes or where hinges, locks or closers are different, a separate heading shall be used. No labeled openings shall be combined with non-labeled openings. Horizontal hardware schedules are not acceptable. Include the following:

   a. Number, location, hand, fire rating, DOS Code, size and material of each door opening (hands and swings to be determined in relation to key side of opening).
   b. Type, style, function, size, finish and quantity of each hardware item.
   c. Name and manufacturer of each item.
   d. Fastening requirements.
   e. Explanation of abbreviations used.
   f. Keying information.

E. Hardware Schedule Index: Furnish an index cross referencing Contract Document door number and hardware group, and supplier's hardware set.

F. Keying Schedule: With the Security Hardware Schedule submit a separate detailed keying schedule conforming to the Government's approved Master Key System for Government review and approval. Entire permanent Medeco (SHW) keying system must be created and procured by a single vendor for the Project. Prepare the Key Schedule using Microsoft Excel and submit in electronic formats. Keying information can be sensitive; at no time shall keying schedule be combined with both project number and any form of city/country/location (including abbreviations and airport codes). Do not include city/country/location name fully or abbreviated in the schedule, as a file name, or in the P.O. of the schedule; the schedule shall be identified by the project number only). Key Schedule shall include the following information:

1. Cover page entitled "Keying Schedule, Section 087145 " with the following information: OBO Project Number (do not include city/country/location name); List of buildings included in the schedule identified by building type (i.e. Utility Building, New Office Building, etc.); General Contractor's Name, address, and phone number; Supplier's name, address and phone number; DS/FSE/TDB (DS Lock Support) complete address; Date of issue; Revision Number; Name, email address, and phone number of the person who drafted the schedule; Purchase Order (PO) or other Contract number.
2. Page two shall include General Information, table of contents that identifies all buildings, previous completed phases, Excel Workbook tabs, OBO Project Number as shown on the Cover page, and OBO Criteria year applicable to project. Each subsequent page shall also have the page number, number of total pages and the OBO project number.
3. Key Schedule spreadsheets shall include the OBO Project Number as shown on the Cover page and shall be organized and subdivided by "Registry Group" type (e.g., Chancery DOSC and DOSN, Annex1 DOSC and DOSN, Annex3 DOSN, Compound DOSN 32 series). Actual Registry numbers shall be generated by Medeco. Refer to Table 1.2 "Registry Group."
4. Spreadsheets shall be divided into Subsets by the Categories described in the Part 2 Article on KEYING (e.g., Exterior FEBR, Interior FEBR, Telecom, CAA, SKD, Roof, refer to the Part 2 Article on KEYING for categories) and shall include the following information for each key:

TABLE 1.2
REGISTRY GROUP
(e.g., Chancery DOSC and DOSN, Annex1 DOSC and DOSN, Annex2 DOSC and DOSN, Annex3 -DOSN, Compound -DOSN):

Door Number	Room Description (e.g., Lobby, telecon, RSO office; except where classifications standards do not	From Room to Room (use room number)	Key ID Number	Quantity				SHW Set	Notes
				Cores	Change Keys	Control Keys	Master Keys		

	allow labeling, in that case no room descriptions shall be provided)								

5. Provide project specific SHW hardware set description for each SHW set. Include set descriptions for all hardware for the FE and FE/BR and non-rated SHW doors and all modifications.

G. Samples: If requested by Project Director/COR, submit one sample of each requested item tagged with full description for coordination with the hardware schedule. These items will remain on file in the Project Director/COR's office until all other similar items have been installed in the project. At that time, items on file will be released for installation in pre-determined Project locations.

H. Operating Instructions: Furnish the Government with one complete set of installation instructions, including special adjusting tools and maintenance instructions listing routine maintenance procedures, possible breakdowns, and repairs, and troubleshooting guides. One complete catalog shall be furnished for each manufacturer listed in the approved hardware schedule.

I. Templates: Furnish templates and approved hardware schedule to door and frame fabricators. Where fabricator cannot work to paper templates, ship templates and or physical hardware to factories of respective manufacturers. Prepay cost for shipping and delivery.

J. Informational Submittals: Submit the following:

1. Certifications specified in the Part 1 Article on QUALITY ASSURANCE.
2. Qualifications Data: Hardware Suppliers Qualification data.

K. Closeout Submittals: Submit specified warranty in accordance with Division 01 requirements.

L. Certification: After completion of hardware installation, submit written certification attesting that hardware has been installed in accordance with manufacturer's templates and instructions and that hardware has not been altered.

1.3 QUALITY ASSURANCE

A. General Requirements: Hardware has been specified by manufacturer's name, brand and catalog numbers for purpose of establishing basis for quality, design and operational function.

1. Provide designated product, or where more than one product or manufacturer is listed, provide equivalent product of one of other listed manufacturers.
2. Obtain each type of hardware from single manufacturer.
3. Hardware Sets within this Section are not complete with respect to thickness of doors, hand, backset, method of fastening, and other detail requirements.

4. Review Drawings and Door Schedules thoroughly and provide required hardware for all openings, including openings that may have been inadvertently omitted from Door Schedules.
5. Should opening be omitted or opening not indicated with hardware set, provide hardware of same quality, design and function as specified for similar openings.
6. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
7. Furnish hardware complete with brackets, plates, fittings, fastenings, and other accessories required for installation.

B. Regulatory Requirements:

1. Comply with Architectural Barriers Act (ABA) in accordance with Chapter 11 of the OBO Building Code to accommodate barrier free design except where specifically indicated by the Government.
2. Provide knurled tactile warning on door hardware to hazardous areas, abrasive coating not acceptable.
3. Comply with NFPA 80 for hardware at fire-rated assemblies.
4. Provide hardware that has been tested and listed by UL or FM for fire-rated assemblies of types that comply with requirements of door and frame labels.
5. Comply with NFPA 70 (model National Electrical Code) requirements for personnel doors to protect workers in applicable electrical spaces.
6. Latches and Locks for Means of Egress Doors (Except where Specifically Indicated Otherwise): Comply with NFPA 101. Latches shall not require more than 67 N (15 lbf) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in accordance with Chapter 1 of the OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO) by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended location and application.

C. Hardware Supplier Qualifications: Door hardware supplier who has been furnishing hardware for a period of not less than two years, and who is, or who employs an Architectural Hardware Consultant (AHC) who will be available at reasonable times during the course of Work for consultation about Project's hardware requirements.

D. Installer Qualification Data for Locks that Utilize a 3-Position Spin Dial or GSA Approved Locks in Accordance with Federal Specifications FF-L-2740 (Locks, Combination, Electromechanical) FF-L-2937 (Combination Lock, Mechanical) or FF-L-2890 Lock Extensions):

1. Submit resumes and training certificates of all installers (present and responsible for each install) documenting that installer has installed GSA approved locks within last three years. Resume shall include at least three references (including contract information) that can provide verification that installer has expertise required to perform successful installation. Installer's qualifications require approval by the Office of Overseas Buildings Operations, Construction Facilities Security Management, Security Management, Security Countermeasures Division, Security Engineering Branch (OBO/CFSM/SM/SCD/SEB) and/or FE/BR Program, and the Project Director/COR. Each installer of the installation

team shall be certified by the manufacturer, certified security industry training institute, or certified by US Government training, as being capable of properly installing the locks. As part of the on-site or factory installation, the Contractor shall provide written documentation to the Project Director/COR that the installer is certified in each specific GSA approved lock installation. Certification to be on the lock manufactures letter head, or USG letterhead and indicate dates of training and what products they are certified to install. Certification is required for each type of lock product (i.e. certification training for installation of a Kaba Mas X-10, does not qualify an individual for the CD-X10 or the S&G2890 series lock).

a. A partial list with hyperlinks of sources of approved training courses include:

1) DOD Lock Program Training *Kaba Mas Lock Training (navy.mil)*
2) Kaba Mas Certified Security Locks Installer Training (KabaMas.com), *Certified Security Locks Installer Training - Kaba Mas*
3) MBAUSA Training Institute (MBAUSA.com), *Kaba-Mas X-10 Factory Certification (mbausa.com)*
4) Lockmasters Security Institute (Lockmasters.com), *Lockmasters Security Institute*
5) Sargent & Greenleaf (sargentandgreeleaf.com), *2890B/2740B Dual Certification Class - S&G (sargentandgreenleaf.com)*

b. Contact the US Department of State, Diplomatic Security Lock Program at DSLockSupport@state.gov if additional information is needed with regards to the training requirements refenced in this section.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with Division 01 requirements.

1. Pack each hardware item separately. Include manufacturer's printed installation instructions, trim, fasteners accessories, and special tools necessary for installation.
2. Legibly mark and adequately label each package indicating opening for which intended. Provide markings corresponding with approved Hardware Schedule.
3. Deliver permanent security cores and keys as indicated in the Part 2 Article on KEYING of this specification to DS Lock Program office. This requirement is not referring to submittals or purchase orders, but actual delivery of cores and keys.

a. For new compounds, delivery shall not be less than 90 days prior to scheduled substantial completion.
b. For a phased projects with turnover and occupancy of a new office building, delivery shall be provided not less than 90 days prior to scheduled substantial of completion of each office building.
c. For renovated office facility, delivery shall be provided not less than 90 days prior to scheduled substantial completion of each renovated office building phase.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

A. See door hardware sets in this Section for approved products.

2.2 HINGES

A. FE/BR Hinges: Hinges shall be in accordance with associated FE/BR tested door and shall conform to requirements in Section 083454 “Forced Entry/ Ballistic Resistant Door Assemblies.” All hinges shall be factory drilled by hinge manufacturer and not by FE/BR manufacturer, or hinge warranty will be voided.

B. For non-FE/BR, door hinges, substitutions require approval from OBO/CFSM/SM/SCD/SEB. These substitutions shall use extra-heavy-duty hinges for double weight doors conforming to ANSI/BHMA 156.1. Hinges shall be non-removable pin. Provide cycle tested hinges per ANSI/BHMA 156.1-2006 to a minimum of 500,000 cycles. Other minimum requirements are as follows:

1. Cycle Testing: 500,000
2. Hinge Pin Rise: None Allowed
3. Hinge Play: 0.38 mm (0.015 in)
4. Vertical Wear: 0.76 mm (0.030 in)
5. Lateral Wear: 1.60 mm (0.062 in)

2.3 CYLINDERS, CORES AND KEYS

A. Provide large format interchangeable core (LFIC) housings, LFIC cores and keys for locks, and other control and locking devices indicated in the Hardware Sets.

B. Security Doors:

1. Acceptable Manufacturers:

a. Medeco Security Locks, Inc. an ASSA ABLOY Group company.
b. No substitutions.

2. Description:

a. Medeco LFIC 32 Series housing and Medeco six-pin 32 series LFIC cores.
b. All cylinders shall be equipped with temporary construction core for use during construction. The contractor is responsible for the purchase of the final cores and coordination of their secure shipment to the project site through DS.

3. Cylinders, Cores, & Keys

a. Provide mortise/rim LFIC housing with tailpieces/cams and LFIC cores for locks and other access control locking devices indicated in the SHW Hardware Sets.

b. Acceptable Manufacturers:

Medeco Security Locks, Inc.,
P.O. Box
3075 Salem,
VA 24153

c. Approved Lock Cores

1) General Work Area (GWA)

Six-pin LFIC Medeco product (32-) with DS GWA/DOSN commercial keyway.

2) CAA/LAA

Six-pin LFIC; Medeco product (32-) with DS reserved keyway (M3 or M4 system keyways depending on project scope).

3) Standard Construction Cores

Six-pin LFIC Medeco Biaxial product (32-) with black finish (22 or BB) and R1 keyway.

4) Lock and Leave

a) Classified lock and leave entry and bypass doors

Six pin LFIC Medeco M4 product with LL-C keyway

b) Unclassified lock and leave entry and bypass doors

Six pin LFIC Medeco M4 product with LL-NC keyway

5) Miscellaneous Non-Standard Cores

Six/five/four pin LFIC or cam locks in Medeco original, M3 original, or M4 as required by specific application. Keyway dependent on the application.

C. The Contractor is responsible for supplying temporary construction cores and associated keys for all cylinders during construction. These shall be different color than permanent cores and consist of the following:

Biaxial R1 keyway - Construction Core part number

with keys: 320201 CC W BI R1 P N N E

16 6 6 00 R1 05 N Operating key
16 6 6 00 R1 08 N Control key

1. Upon installation of final cores, construction cores will be returned to the Construction Contractor.

2.4 KEY CONTROL ACCESSORIES

A. Key Management System:

1. The total quantity of key capabilities required shall be determined by total number of all keys required to open all doors in the project (including SHW sets, HW sets, and designated groups and specialty keys), as defined in the Part 2 Article on KEYING.

   a. For compounds with multiple office buildings, provide a key management system for each building with an MSG Post.

2. Control location for the system is adjacent to or within line of sight of Post One. Refer to the Part 3 Article on INSTALLATION for additional installation requirements.

   a. For a post, or compound, without a MSG detachment, provide cabinets only for the non-CAA doors.
   b. For new office buildings on an existing compound, if they include a new Post One (manned by MSG or local), provide a Key Management System per this section.

      1) For compounds with an existing Key Management System, in lieu of installing a completely new system in the new building, the existing system shall be expanded if directed in project contract documents (e.g., SOW or design documents).

3. Acceptable Manufacturer and Product:

   a. Morse Watchmans, Inc., 2 Morse Road, Oxford, CT 06478. Model: KeyWatcher Illuminated System,

      1) Description: Furnish Morse KeyWatcher key management system (DOS PN KW-8494). The system shall provide a minimum 48 key main cabinet and a minimum 48 key secondary cabinet (one for Classified Access Area (CAA) keys and one for non-CAA keys) that are both expandable. The system shall be expandable in 32 key increments, unit (DOS PN KW-8495). System shall be provided with the Key-Pro software package for complete monitoring of the key control system. Provide keypad and control console with one cabinet.

2) Dimensions: 525 mm (21 inches) w x 850 mm (34 inches) h x 325 mm (13 inches) d; installed semi-recessed
3) Electrical: 100 – 240 VAC, 50 – 60HZ
4) Modifications to Standard Model: The Standard factory cam locks are required to be replaced. Four pin cam locks (DOS PN FSS-KW5 from Federal Security Systems 8580 Cinderbed Road LortonVA 22079) shall replace the standard three pin locks. The locks shall be pinned alike for all KeyWatchers at a given post and each post shall have a unique key.
5) Provide smartkey tags that are "red" color for CAA. Provide smartkey tags that are "black" color for non-CAA. Do not use "black" or "red" key tags in other State Department key watch systems used (i.e., facilities or GSO).

B. Key Drawer: In Post One, provide a lockable key drawer capable of storing a minimum of 200 tagged/labeled keys in a manner that is easy to use (organize and reach/retrieve keys).

C. Stand-Alone Key Cabinets: In the RSO suite provide Global Industries Steelmaster Unitag 200 key (2019200D03) wall-mounted key cabinet with dual control system including envelopes, labels, tags with self-locking clips, receipt forms, three-way visible card index, temporary markers, permanent markers and metal cabinet. Equip the cabinet with pin tumbler locking mechanism. Provide unit capable of storing a minimum of 200 keys.

1. Refer to Section 087135 "Non-Security Door Hardware" for key cabinets serving General Services Office (GSO) and Facility Management (FM) Office.

2.5 POWER DOOR OPERATORS FOR FORCED ENTRY OR ASTM BLAST RATED DOORS

A. Acceptable Manufacturers:

1. Each forced entry or ASTM/blast rated door manufacturer shall provide a power door operator that has been tested and approved by US Department of State, Diplomatic Security Lock Program.

B. Standard: BHMA A156.19.

C. Description: Units shall be ; surface mounted to frame or door leaf head, and power door operators shall operate as manual door closers unless power door is activated and when power is lost, as well as having the ability to operate in a fully automatic mode.

1. Activation of power door shall open doors to 90-degrees.
2. Powered operators shall be 24vDC and/or 120/240 dual voltage 50/60 hertz electrically powered. Furnish actuators with satin stainless steel dress plates embossed with the universal handicap symbol, except as noted below. Refer to Chapter 11 of the OBO Building Code for additional power door operator requirements.

a. 24vDC and/or 120/240 dual voltage 50/60 hertz electrically powered operators are not required to provide actuators if they are designed to operate in the fully automatic

mode and opening force is no more than 22 N (5lbf) to fully open the door and approved by OBO/CFSM/SM/SCD/SEB.

3. Opening Force:

   a. If Power Fails: Not more than 67 N (15 lbf) required to release a latch if provided, not more than 133 N (30 lbf) required to manually set door in motion, and not more than 67 N (15 lbf) required to fully open door.
   b. Accessible Interior Doors: Not more than 22 N (5 lbf) to fully open door.

4. Entrapment Protection: Not more than 67 N (15 lbf) required to prevent stopped door from closing or opening.

D. Required Features: Manufacturer's standard cast iron construction.

1. Rack and pinion construction with compression spring.
2. Adjustable Closing speed and/or latching speed.
3. Adjustable latching force allowing adjustment up to 50 percent in field to suit individual door conditions.
4. Adjustable backcheck.

2.6 AUXILIARY HARDWARE

A. Acceptable Manufacturers:

1. Hager Companies.
2. Ives Hardware; an Ingersoll-Rand Company.
3. Rockwood Manufacturing Co., Inc.

B. Manual Flush Bolts: Top manual flush bolt shall not exceed 1880 mm (74-inches) from floor to centerline.

C. Floorstops and Doorstops: Furnish wall stops equal to Ives 407CVX or Rockwood 400 for all doors without a closer and wherever trim strikes wall for all doors equipped with power door operators and for doors with closers that do not include a stop built into the closer. Where floor and wall stops are not suitable, furnish surface mounted overhead stops All wall or floor mounted doorstops must be installed at a distance of 50 percent or greater than the door's width from the door's inactive edge width along the door leaf. Floor stops are only to be used for doors in alcoves, to avoid trip hazards.

D. Silencers: Furnish rubber silencers equal to Ives SR64 or Rockwood 608 for hollow metal frames; three per single door and four per pair. Silencers are not required at doors specified to receive continuous weather-stripping or seals.

2.7 OVERHEAD STOPS AND HOLDERS

A. Acceptable Manufacturers:

1. Architectural Builders Hardware.
2. Glynn-Johnson; an Ingersoll-Rand Company.
3. Rixson, an ASSA ABLOY Group company.

B. Where wall stops are not suitable, furnish surface overhead stops equal to Glynn-Johnson 450 Series. In Hardware Sets where door closers are specified, provide closer arms with built-in stops (LCN No.3077-CNS). Floor stops are not allowed without written authorization of OBO.

2.8 THERESHOLDS, WEATHER-STRIPPING AND SEALS

A. Acceptable Manufacturers:

1. Hager Companies.
2. National Guard Products.
3. Pemko Manufacturing Co.
4. Reese Enterprises, Inc.
5. Zero International, Inc.

B. Description: Refer to the Hardware Sets for grade and style. Where required, field modify thresholds to accept strikes for flush bolts and exit device rods.

C. Smoke Seals: Where required by applicable code, at doors located in Smoke Barrier Partitions, provide smoke seals equal to Pemko S88 at the head and jambs; and at pairs of doors, one Pemko 375CR or two Pemko 303AS astragal seals as appropriate; coordinate with Drawings and schedules.

D. Astragals: Where indicated in the Hardware Sets, provide overlapping astragals equal to Pemko 357SP. Astragals shall be full height, installed on the "threat" side of the opening.

2.9 ACOUSTICAL TREATMENT

A. Provide full door gasketing/acoustical seals with flat threshold installed to maintain STC rating of surrounding walls.

B. Certification: Provide certification that the door construction utilized has been tested at an independent laboratory in accordance with ASTM E90 and that the STC determined in accordance with ASTM E413 is not less than that specified. The laboratory referenced in the certification must be qualified under the National Voluntary Laboratory Accreditation Program (NAVLAP) of the U.S. Bureau of Standards. Certification must reference laboratory name, test report number, and date of test; substitution of test data not in accordance with ASTM E90 and E413 will not be acceptable.

C. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

D. Secondary Requirements: If fire resistance is required, certify that assemblies have been tested in accordance with UL 10B for labeled fire doors and frames and meets the requirements of NFPA 80. If seismic stability is required, submit calculations showing ability of door systems to withstand pertinent seismic forces.

2.10 ELECTROMAGNETIC DOOR HOLDERS

A. Acceptable Manufacturers:

1. As indicated in HARDWARE SETS – SECURE DOORS in this Section, no exceptions.

2.11 MAGNETIC DOOR CONTACT

A. As indicated in HARDWARE SETS – SECURE DOORS in this Section, no exceptions, except as noted below.

B. Magnetic door contacts shall match the approved technical security (TSS) design and the DOS Technical Security Installation Requirements Guide.

C. Where the TSS and DOS Technical Security Installation Requirements Guide do not require a magnetic door contact, but the SHW set includes a magnetic door contact, the door contact may be deleted from the door, provided the following conditions are met:

1. Submit, in table format, a detailed list indicated which doors will have the contact deleted, the SHW set and from what room to what room is impacted by room name, unless room name would make the document classified and then use room numbers (i.e. exterior to warehouse corridor, or room 1121 to room 1123). List shall be provided as part of the CD-2 submittal and noted in the door hardware schedule.
2. Failure to provide the list of doors to have the magnetic contact deleted will result in DOS requiring the magnetic contacts to be installed on the doors, even if the TSS plan may not require them.

2.12 KEYING

A. The following is the DOS required keying plan for SECURITY DOOR OPENINGS:

1. All keying systems must be factory generated and recorded.

a. All key operated locks on individual doors and multiple doors into the same space shall be keyed alike, unless noted otherwise.
b. Grand Master and Great Grand Master systems and engineering keys are not permitted.

c. Office Buildings (i.e., New Office Buildings (NOB), New Office Annexes (NOX) Existing Office Buildings (EOB) shall use the Medeco products with both reserved commercial Keyways. Each compound shall have one unique factory generated registry number for controlled access area (CAA) and limited access area (LAA) in office buildings and one registry for non CAA. Lock and leave buildings shall use either LL-C or LL-NC keyways as primary and secondary entry doors in accordance with facility type. Exceptions exist for residential buildings. 2.3.B.3

d. Residential buildings, Marine Security Guard Residences (MSGR), to include MSGR's and CMR's that are conjoined with an office building, warehouse (WHE), support annexes with shop areas (SPX), recreational buildings (REC), USAID Annexes, mechanical/engineering/plumbing (UTL) buildings, Compound Access Control (CAC) facilities shall use the Medeco product (32-) with DOSN/GWA Keyway and shall use one registry number for all the commercial keyways on compound, regardless of the number of building on the compound.

   1) When a residence is conjoined with an office building, any doors between the two shall follow the office building keyway and registry requirements.

e. All exterior forced entry (FE) and forced-entry/ballistic-resistant (FE/BR) doors shall have an interior cylinder with a non-removable thumb turn on the Force Entry Locks (FELs), except as noted in the security door hardware descriptions.

f. This specification uses the following definitions and nomenclature when describing the key requirements:

   1) Keyed Alike (KA) – Cylinder/core pinning which results in the same change key working two or more locks.
   2) Keyed Different (KD) – Cylinder/core pinning which results in a different change key being required for each of two or more locks.
   3) Single Keyed Alike (SKA) – single or multiple cores on multiple openings with unique pinning, change, and control keys; part of the registry, not pinned to any MK and not associated with any cores in any other Master Keyed System used at post.
   4) Single Keyed Different (SKD) – single or multiple cores with unique pinning, change, and control keys; part of the registry, not pinned to any MK and not associated with any cores in any other Master Keyed System used at post.
   5) Master Keyed (MK) – Cylinder/core pinning which results in operation by both a change key and one master key.
   6) Change key - operates lock/s
   7) Control key - install/remove interchangeable core/s
   8) Bypass key / Bypass lock – A lock and its key that are not the primary means of securing or accessing a space but exist to bypass the access control system or day lock, when needed.

g. Security doors shall be KD and MK within categories identified below and are per building, even if multiple buildings share a registry number (e.g., all exterior FEBR doors in office building A shall be KD and master keyed together for building A for office building B, all exterior FEBR doors shall be KD and master keyed together

with all exterior FE/BR doors in building B). Exceptions for CACs are identified in subparagraph l:

1) Exterior building perimeter FE and FE/BR doors
2) Interior FE and FE/BR doors
3) Technical security systems (TSS) EC Room doors (when multiple EC rooms or sub-EC room exists; otherwise, EC room is SKD).
4) Groups 4 and beyond - MK by floor, except for the PCC, secure conference rooms; except as indicated by the SKD and KD doors in sections i and j below.

h. The following Security doors shall be KA and SKD within their own numbered categories or SKD if only a single door access the space. Each numbered category shall be KD from all others:

1) Roof access doors
2) Safe Haven, Compound Emergency Sanctuary or Safe Area
3) Limited access area (LAA) Lock and Leave doors
4) CAA+ suites

i. The security doors shall be SKD, and either KD for a single lock on a single door or KA for multiple doors/locks into the same area. No two areas shall be KA:

1) Telephone Equipment Rooms (PBX, TSEF, MTS)
2) PCC Generator Room
3) React Room or MSG Suite
4) Doors within the PCC
5) Secure Conference rooms
6) Primary Lock and Leave doors
7) EC Room – if only one
8) PCC Switchgear
9) Secure Command Center (SCC)
10) Tactical Operation Commands (TOC)
11) Post 1
12) Guard Booths
13) Pharmacy
14) Roof Maintenance Sheds (RMS)

j. The following doors shall be SKD:

1) PCC

k. All CACs on a compound shall be keyed as follows:

1) Street side exterior doors – KA and NMK (SKA).
2) Compound Side exterior doors, to include sally port – KA and NMK (SKA) (KD from the street side doors);
3) CAC guard booth – SKD.
4) CAC utility demarcation rooms – SKD.

5) Interior/compound/sally port non-forced entry control doors (EC room, pump room, telephone and/or electrical rooms) shall be SKD.

l. Chief of Mission Residence (CMR) and Residences with FE or FE/BR doors – KA all exterior doors (per individual building or individual dwelling unit).

1) Safe areas in stand-alone residences shall be SKD.
2) Safe areas in multiple unit buildings (apartments or townhouses) shall be KD and MK by building.

m. Specialty keys:

1) LAA or CAA access hatches shall be, SKA/SKD when multiple access hatches open into the same space.
2) Lock and leave entry and bypass doors shall be SKA/SKD.
3) GWA access hatches shall be SKA.
4) Exterior manholes/handholds; see Section 337105 “Underground Ducts and Raceways” for lock requirements:

a) TSS shall be SKA
b) Electrical shall be SKA
c) Communication (not cable/local TV) shall be SKA
d) Water and sewer shall be SKA
e) All other misc. utilities shall be SKA
f) KA applies per manhole discipline/function.

B. The Project Director, the General Contractor's representative, and either the RSO or the PSO shall meet to determine if there are any special keying conditions required so they may be incorporated into the keying schedule and provide recommendations for any deviation from the above specification to OBO/CFSM/SM/SCD/SEB for review and approval before the keying plan/schedule is submitted.

1. The General Contractor shall submit a keying plan/schedule for the entire project, or phase as noted below, at the same time of submission of the secure door shop drawings, or at the time of FE hardware submission for FE/BR only projects. Medeco keying system shall be created and procured by a single vendor for the Project except for the keys required for the ACF.

a. The General Contractor shall provide ACF keys that are on a separate commercial keyway 90 days before ACF is to be put into use.

2. For a phased project that includes multiple office buildings, the General Contractor may elect to break the keying plan/schedule submission out to reflect the phases with the approval of OBO/CFSM/SM/SCD/SEB, or if required by the SOW and/ or design documents, and shall meet the following requirements:

a. The registry numbers and keying requirements shall be based on the requirements for the entire project.

b. The registry from any earlier phases shall be used in accordance with the requirements herein and shall be an extension of the keying plan approved in earlier phases to include number of the keys.
c. Each keying plan/schedule for subsequent phase shall include the earlier phases and shall be clearly annotated showing what is existing.
d. Keying sequences shall be a continuation of earlier submissions (i.e., if earlier phase for a registry number stopped at SKD5, the new phase should start at SKD6) and if a number is skipped in a sequence the number shall be labeled as "not used" or "reserved" (e.g. SKD12, SKD13 – not used, SKD14).

C. Key Quantities: Furnish plain bow keys of nickel silver material in the following quantities:

1. For each master key system, provide:

a. Four master keys (include two for key control cabinet and two for MSG keys).
b. One control key.
c. Two change keys per keyed different core.

2. For each individually KD or SKD core, provide:

a. One control key.
b. Four change keys. (Include two for key control cabinet and two for MSG keys)

3. For each individually keyed alike (KA) core, provide:

a. One control key.
b. Two change keys per door.

4. For Specialty keys, provide:

a. LAA/CAA Access Hatches, KA/SKD for multiple hatches accessed from within a suite or common space or SKD for a single hatch:

1) One control key.
2) Two change keys.

b. GWA Access hatches (4 total change keys) and Manholes/handholes (provide for 5 keys, see HW and manhole/handhold specifications.

5. For new compounds, buildings or major building rehabs provide MSG Keys (react key ring/s) for two MSG Keysets:

a. Six sets of keys consisting of master keys, and SKD door keys (no specialty keys) in such a manner to use the minimum number of keys possible to open all doors in the project.

6. For each construction key system, provide:

a. All construction cores shall be black in finish.
b. Construction cores and keys shall be turned over to the USG Project Director or the Site Security Manager (SSM) for distribution and control during the project duration.
c. Two control keys.
d. Operating change keys per quantity of construction cores as follows:

1) One to 10 doors: four keys.
2) 10 or more doors: 20 or as directed by the USG.
3) For renovations with an active MSG Post, provide six additional keys for the MSG keys.

D. Identification and Control

1. Identify master keys (MK) with registry number; do not stamp with master key, letter M, or similar identification; manufacturer's trademark or identification not allowed.
2. Stamp master keys with DO NOT DUPLICATE.

E. Delivery

1. Deliver construction cores, construction control keys, and construction keys to the Project Site.
2. Permanent cores, change keys, and permanent control keys shall be individually packaged by door, identified by door and lock. Shipment shall be by manufacturer via prepaid freight to:

DS Lock Program
5800 Barclay Drive, Suite 5
Alexandria, Virginia 22315-5700

3. Clearly mark shipping boxes; indicate “OBO PROJECT AND/OR PURCHASE ORDER NUMBERS ONLY”. A pinning schedule is required for all prepared systems.

2.13 FINISHES

A. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturers' standard metal alloy of composition, temper and hardness, but in no case of lesser quality than specified or inferred by use of a particular manufacturer's number, style or grade, or as established by appropriate referenced specification listed herein.

B. Finishes: Finishes shall conform to the quality of finish including thickness of plating or coating (if any), composition, hardness and other qualities complying with manufacturers' standards, but in no case less than the standards established by ANSI/BHMA A156.18.

1. All exposed hardware except door closers shall be satin stainless steel, ANSI/BHMA 630/US32D. Closers shall be painted to match satin stainless steel. Hinges shall be satin

stainless steel. Items not available in stainless steel shall be furnished with satin chrome finish, ANSI/BHMA 626/US26D.

C. Prime Coated Items: Field painted under Division 09 painting section.

2.14 FASTENERS

A. Manufacture hardware to conform to published templates, generally prepare for machine screw installation. Do not provide hardware that has been prepared for self-tapping or sheet metal screws except as specifically indicated.

1. Furnish screws for installation with each hardware item. Provide Phillips flat head or oval head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces of other work, to match the finish of such work as closely as possible, except as otherwise indicated.
2. Provide concealed fasteners for hardware units that are exposed when the door is closed, except to the extent no standard manufactured units of the type specified are available with concealed fasteners.
3. Do not use through bolts for installation except where it is not possible to adequately reinforce the work, to accept machine screws or concealed fasteners or other standard type, to satisfactory avoid the use of through bolts. Grommet nuts and cleat nuts are not acceptable.

B. Furnish fasteners that are compatible with both the units fastened and the substrates, and which will not cause corrosion or deterioration of hardware, base material reinforcement, or fastener. Furnish wall stops with expansion anchors and machine screws. Furnish thresholds with lead anchors and 1/4-20 stainless steel flat head socket cap screws.

2.15 ACCESSORIES

A. Door Coat and Hat Hook: Provide cast aluminum, double prong hooks on inside face of all private office doors and toilet rooms; Ives Model No. 405 wide body design (ANSI/BHMA A156.16, L33113).

2.16 DOOR CONTACTS

A. Door Contacts: As specified in the SHW sets to include vault doors and Core area with following exception:

1. Doors without card readers providing access to LAA and Restricted CAA shall use the Cinch Model Ce-M1ZRST. Refer to Section 283105 “Technical Security Intrusion Detection Systems.”

2.17 MULTI-POINT LOCKING HARDWARE

A. Multi-point locking hardware: As specified in the SHW sets. Hardware must be approved as part of a door manufacturer's certification. When used on a Forced Entry door it must be tested as an approved part of the door to SD-STD-01.01 Rev H. When required as part of the perimeter blast resistant design of a building, it must be tested as an approved part of the door to ASTM F2927-xx and DOS DS ASTM F2927 supplement. See door specific requirements in Specification 083454. Only multi-point lock models tested on specific certified door manufacturer doors are approved. No substitutions.

B. Multi-point locking hardware is used in SHW-31 – SHW-38. "Multi-lock Device" function in SHW is defined as follows: [AST][PST][TLF]-[KA][MAC][EAC]-[MBR][DE][RTE] (ie: LP2-101-MBR RTE)

1. AST – Attack Side Trim

   a. X- None
   b. L- Lever
   c. P- Pull
   d. T- Thumbpiece
   e. D- Dummy

2. PST – Protected Side Trim

   a. X – None
   b. L – Lever
   c. P – Panic

3. TLF - Trim Lock Function

   a. 0 – Dummy [No latching or locking hardware device]
   b. 1 – Passage [Latch bolt operated by handle form either side at all times]
   c. 2 – Entry [Exterior handle/trim always locked except for momentary KAC or EAC. Interior handle always free access.]
   d. 3 – Entry [Exterior handle/trim always locked except for momentary KAC, MAC or EAC. Interior handle always free access.]
   e. 4 – Apartment or Dormitory [Exterior handle/trim locked except for momentary KAC or EAC. Or if by KAC handle/trim set to allow free passage. (dogging of MP bolts in retracted position is not permitted). Interior handle always free access.]
   f. 5 – [Reserved]
   g. 6 – [Reserved]
   h. 7 – Institutional or Utility [Exterior handle/trim locked except by KAC handle/trim set to allow free passage. Interior handle/trim locked except by KAC handle/trim to allow free passage. (dogging of MP bolts in retracted position is not permitted.)
   i. 8 – Institutional or Utility [Exterior handle/trim locked except for momentary KAC, MAC, or EAC. Interior handle/trim locked except for momentary KAC, MAC, or EAC.]

j. 9 – Exit [Deadlocking latch bolt operated by inside handle only. Blank pate outside projection]

4. KA – Key Access

a. 0 – None
b. 1 – Outer [attack](Single)
c. 2 – Inner [protected] (Single)
d. 3 – Both [attack and protected]

5. MAC – Manual Access Control

a. 0 – None
b. 1 – Outer [attack](Single)
c. 2 – Inner [protected] (Single)
d. 3 – Both [attack and protected]

6. EAC – Electric Access Control

a. 0 – None
b. 1 – Outer [attack](Single)
c. 2 – Inner [protected] (Single)
d. 3 – Both [attack and protected]

7. Options:

a. MBR – Motorized Bolt Retraction
b. DE – Delayed Egress
c. RTE – Request to Exit Switch

d.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with Division 01 requirements.

3.2 INSTALLATION

A. Install hardware plumb, level, square and true to line in accordance with manufacturer's templates and Project conditions.

1. Install fire rated hardware in accordance with NFPA 80.

2. Where cutting and fitting is required on substrates to be field painted or similarly finished, install, fit, remove and store hardware prior to finishing. Reinstall hardware after finishing operations are completed.
3. Do not install surface mounted items until finishes have been completed on the substrate.
4. Reinforce attachment substrates as necessary for installation and operation.
5. Mortise work to correct size and location without gouging, splintering or causing irregularities in exposed finish work.
6. Fit faces of mortised components snug and flush without excessive clearance.
7. Set thresholds at exterior doors in bed of sealant. Remove excess sealant.

B. Hardware Mounting Heights: Mount hardware units at heights recommended by DHI (see "Recommended Locations for Builders Hardware") on custom doors except as otherwise indicated or required to comply with governing regulations, and except as may be otherwise indicated.

C. Cylinder Cores: When instructed, Contractor shall remove temporary construction cores. Permanent cores will be installed by the Government. After installation of the permanent cores, construction cores, operating keys, and control keys remain the property of the contractor and are to be returned to the contractor.

D. Power Door Operators: Where post mounted actuator buttons are indicated, run signal wire below grade in conduit complying with Division 26. Elsewhere, run signal wire concealed in Technical Security System conduit. Run pneumatic lines between pumps and door operators concealed. At curtain walls, run pneumatic lines concealed in metal trays finished to match curtain wall.

E. Key Management System: Install primary and secondary cabinet immediately adjacent to each other. Place cabinet with keypad and control console as the right of the two cabinets (as viewed facing the cabinets). Provide power and data outlets at keypad and control console. Place system in conformance to accessibility requirements of the OBO Building Code.

F. Door Closer: Ensure the valve on the back side of the cylinder is screwed in before installing on door leaf. Ensure the closer arm is installed level and parallel to the door leaf. Set back-check to ensure the closer arm does not hit the door stop pin inserted into the closer arm bracket.

G. Door Sweep: Install door sweep on the attack side of the door leaf.

3.3 ADJUSTING

A. Check and adjust each operating hardware item to ensure correct operation and function.

1. Adjust closer sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 75 mm (3 inches) from the latch, measured to the leading edge of the door.
2. Ensure weather-stripping and seals do not inhibit closing and positive latching of door.
3. Lubricate moving or operating components as recommended by hardware manufacturer. Use graphite type lubrication if none other is recommended.

4. Replace defective materials or units that cannot be adjusted to operate as intended. Reinstall items found improperly installed.
5. Prior to date of Substantial Completion, readjust and reapply lubricant to hardware items as necessary.

3.4 DEMONSTRATION

A. Instruct Government's designated personnel in proper adjustment and maintenance of hardware at time of Substantial Completion.

1. In the presence of the Government's representative, demonstrate that the keys operate freely in designated unit.
2. Hardware supplier: Completely set-up key control system with keys tagged and placed in cabinet. Cross index system executed with appropriate information typed in on index cards and instruct Government's designated personnel in the proper use of the system.

3.5 HARDWARE SETS – SECURE DOORS

A. Refer to the following pages for secure hardware sets.

SHW-1

QUAN.	ITEM	MODEL	MFR.	NOTES
5	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
11	Panic Exit Device	QEL-98NL-630-CON	Von Duprin (Allegion)	
1 ea.	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1 ea.	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1 ea.	Closer	4040XP - Cush - 689	LCN	
1 ea.	Electric Power Transfer	DOS Approved	DOS Approved	
1 ea.	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-1A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP - Cush - 689	LCN	
1	Card Reader	Various Manufacturers	-	1
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-1B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL-98NL-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	
1	Door Control Relay Interface	941-R	AES Security	1
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-1C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Card Reader	Various Manufacturers	-	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	5
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2
1	Door Control Relay Interface	941-R	AES Security	3
1	Door Control Module	941-M	AES Security	4
1	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	1
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	

1 Set	Silencers	SR64 GRY	Ives	

1: The accessibility wall switches are to be wired to operate only after access is granted by the guard on the ingress or attack side.
3: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.
4: Installed at Post 1 control console.
5: Connect tubing between auto-equalizer and transfer hinge. Leave 300 mm of tubing attached to the double ended barbed fitting in the frame for future connection by the technical security installation team.

SHW-1D

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL-98NL-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#*	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#	Interchangeable Core	320201H-26	Medeco	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-2

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	1
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	2
1	Sill Sweep	315CN	Pemko	2
1 Set	Silencers	SR64 GRY	Ives	3

1: Strikes are non-fail safe (fail secure).
2: At exterior doors.
3: At interior doors.

SHW-2A

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL-98NL-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#*	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#*	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#*	Interchangeable Core	320201H-26	Medeco	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	2
1	Sill Sweep	315CN	Pemko	2
1 Set	Silencers	SR64 GRY	Ives	1

1: At interior doors
2: At exterior doors.

SHW-2B

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	98EO-630	Von Duprin (Allegion)	
1	Mechanical Pushbutton Combination Lock	L(hand)P1020M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	2
1	Sill Sweep	315CN	Pemko	2
1 Set	Silencers	SR64 GRY	Ives	1

1: At interior doors.
2: At exterior doors.

SHW-2C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#*	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#*	Interchangeable Core	320201H-26	Medeco	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-2D

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL-98NL-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
#	Interchangeable Core	320201H-26	Medeco	
#	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	1
1	Door Control Relay Interface	941-R	AES Security	
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	

1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-2E

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Mechanical Pushbutton Combination Lock - Cylindrical Prep. Push Buttons - Both Sides	EE1021M / EE1021M-26D-41	DormaKaba (Simplex)	
2	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-2F

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Card Reader	Various Manufacturers	-	1
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2
1	Door Control Relay Interface	941-R	AES Security	2
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	

1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections
2: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-2G

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML 20932 x SEC x NSM x 32D	Corbin Russwin	
2	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
2	Card Reader	Various Manufacturers	-	1
1	Electric Power Transfer	DOS Approved	DOS Approved	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: DIPLOMATIC SECURITY (DS) APPROVED CARD READER SHALL BE PROVIDED BY TECHNICAL SECURITY INSTALLATION CONTRACTOR; SEE DIVISION 28 SECTIONS

SHW-3

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML2067 x NSM x 32D w/ Scalp Plate 402F30	Corbin Russwin	
-	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#*	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#*	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-3A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-3B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-3C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1 ea.	Lock Set	ML2067 x NSM x 32D w/ Scalp Plate 402F30	Corbin Russwin	
1 ea.	Interchangeable Core and Mortise Cylinder	32-0200-26D x CT-Z00	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Interior Keyed Cylinders	Model and quantity to match certified/rated door	Medeco	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1 ea.	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1 ea.	Closer	4040XP - Cush - 689	LCN	
1 ea.	Magnetic Switch	MSS-312C	Magnasphere	
1 ea.	Sill Sweep	315CN	Pemko	1
1 Set	Weather Stripping	332CR	Pemko	1
1 Set	Silencers	SR64 GRY	Ives	

1: At exterior doors.

SHW-4

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML2067 x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Viewer (peep)	Model to match certified/rated door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Smoke Gasket	S88D	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-4A

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML2067 x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Closer	4040XP - Cush - 689	LCN	
1	Electormagnetic Door Release	999M-689	Rixon	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Viewer (peep)	Model to match certified/rated door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Smoke Gasket	S88D	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-4B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromechanical Combination Lock	CDX-10 (GSA Specification FF-L-2890)	KabaMas	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Viewer (peep)	Model to match certified/rated door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Smoke Gasket	S88D	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-4C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Viewer (peep)	Model to match certified/rated door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Smoke Gasket	S88D	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-5A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL98TP-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2
1	Door Control Relay Interface	941-R	AES Security	2
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

2: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-5B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL-98EO-630-CON	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	1
1	Door Control Relay Interface	941-R	AES Security	1
1	Door Control Module	941-M	AES Security	
1	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-5C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL98TP-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-5D

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	98EO-630	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-5E

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL98TP-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2
1	Door Control Relay Interface	941-R	AES Security	2
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Card Reader	Various Manufacturers	-	
1	Electric Power Transfer	DOS Approved	DOS Approved	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	

1 Set	Silencers	SR64 GRY	Ives	

2: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-6

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Panic Exit Device	98EO-630	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
2	Closer	4414ME-REGARM-689-handing-24VDC	LCN	
2	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Stile Gasket	375CR	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-6A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Panic Exit Device	QEL-98NL-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
2	Closer	4414ME-REGARM-689-handing-24VDC	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
2	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Stile Gasket	375CR	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-6B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
-	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
2	Closer	4414ME-REGARM-689-handing-24VDC	LCN	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Card Reader	Various Manufacturers	-	1
2	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Stile Gasket	375CR	Pemko	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-7

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-7A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Panic Exit Device	QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Smoke Gasket	S88D	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-7B

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Panic Exit Device	98EO-630	Von Duprin (Allegion)	
1	Mechanical Pushbutton Combination Lock	L(hand)P1020M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
3	Silencers	SR64 GRY	Ives	

SHW-7C

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-7D

QUAN.	ITEM	MODEL	MFR.	NOTES

SHW-7E

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	2
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Smoke Gasket	S88D	Pemko	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

2: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-7F

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock set/Deadbolt with Panic Bar	2890-P-0000-S#	Sargent and Greenleaf	
1	Rim Cylinder	320475H-26-Y32 w/ Tapered Cylinder Collar 94-0188-26	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock	2937-200	Sargent and Greenleaf	2
1	Card Reader	Various Manufacturers	-	1
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Smoke Gasket	S88D	Pemko	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections
2: Install in 2890 Hardware

SHW-7G

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-7H

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock set/Deadbolt with Panic Bar	2890-L-0000-S#	Sargent and Greenleaf	1
1	Rim Cylinder	320475H-26-Y32 w/ Tapered Cylinder Collar 94-0188-26	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock	2937-200	Sargent and Greenleaf	2
1	Card Reader	Various Manufacturers	-	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Smoke Gasket	S88D	Pemko	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

1: Strike number should be specified depending on swing of the door
2: Install hardware in 2890 hardware

SHW-7I

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock set/Deadbolt with Panic Bar	2980-P-0X10-S [#]	Sargent and Greenleaf	1
1	Rim Cylinder	320475H-26-Y32 w/ Tapered Cylinder Collar 94-0188-26	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Smoke Gasket	S88D	Pemko	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

1: Strike number should be specified depending on swing of the door

SHW-7J

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock set/Deadbolt with Panic Bar	2890-L-X10-S#	Sargent and Greenleaf	1
1	Rim Cylinder	320475H-26-Y32 w/ Tapered Cylinder Collar 94-0188-26	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	2
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Smoke Gasket	S88D	Pemko	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

1: Strike number should be specified depending on swing of the door
2: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-8

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-98EO-F-630-CON	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Fire Door Magnetic Lock/Display Panel	CC-8946	Moniteq	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Fire Door Control Module	AES-945	AES Security	1
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Located remotely in guard/MSG Booth

SHW-8A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
-	Certified Forced Entry Lock with Interior Keyed Cylinders	Model and quantity to match certified/rated door	Medeco	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#	Interchangeable Core	320201H-26	Medeco	
1	Dummy Pull Trim	990DT-630	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Viewer (peep)	Model to match certified/rated door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-8B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
-	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Fire Door Magnetic Lock/Display Panel	CC-8946	Moniteq	1
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Fire Door Control Module	AES-945	AES Security	
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Located remotely in guard/MSG Booth

SHW-8C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
#	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Fire Door Magnetic Lock/Display Panel	CC-8946	Moniteq	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Fire Door Control Module	AES-945	AES Security	2
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Card Reader	Various Manufacturers	-	1
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	

1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections
2: Located in guard/MSG Booth

SHW-8D

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	98EO-630	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-8E

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL98DT-F-630-CON	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Fire Door Magnetic Lock/Display Panel	CC-8946	Moniteq	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Fire Door Control Module	AES-945	AES Security	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
3	Silencers	SR64 GRY	Ives	

SHW-9

QUAN.	ITEM	MODEL	MFR.	NOTES
1 ea.	Electromechanical Combination Lock	X-10 (GSA Specification FF-L-2740A)	KabaMas	
1 ea.	Balanced Magnetic Switch	ESM26T-KBS	East Coast Security	
1	Door Viewer (peep)	Model to match certified/rated door	Various Manufacturers	

SHW-9A

QUAN.	ITEM	MODEL	MFR.	NOTES
1 ea	Balanced Magnetic Switch	ESM26T-KBS	East Coast Security	
1 ea.	Door Viewer (peep)	Model to match certified/rated door	Various Manufacturers	

SHW-10

QUAN.	ITEM	MODEL	MFR.	NOTES
1	Electromechanical Deadbolt Lock	8497-102	Sargent and Greenleaf	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Adjustable Cylinder Collar	CP-160180	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Armored Cable	271	Alarm Lock	
1	Day Gate Installation Kit	Manufacturer Specific items - By Vault Supplier	Various Manufacturers	

SHW-10A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Armored Cable	271	Alarm Lock	1
1	Day Gate Installation Kit	Manufacturer Specific items - By Vault Supplier	Various Manufacturers	
1 Set	Silencers	SR64 GRY	Ives	

1: Armor Cable is from junction box in wall to day door frame. When day door mounted to vault door EPT (21C) is from door frame to door

SHW-10B

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	1
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Armored Cable	271	Alarm Lock	2
1	Day Gate Installation Kit	Manufacturer Specific items - By Vault Supplier	Various Manufacturers	3
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections
2: Armor Cable is from junction box in wall to day door frame. When day door mounted to vault door EPT (21C) is from door frame to door
3: Day door provided by vault door manufacturer. Glazing panels shall be minimum 13 mm thick laminated glazing.

SHW-11

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Electromechanical Combination Lock	CDX-10 (GSA Specification FF-L-2890)	KabaMas	
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

SHW-11A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock	8565 x 101	Sargent and Greenleaf	
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

SHW-11B

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock set/Deadbolt - Panic Bar - Exit Only (GSA Type X)	2890-P-0000-S#Exit	Sargent and Greenleaf	1
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Smoke Gasket	S88D	Pemko	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

1: Strike number should be specified depending on swing of the door.

SHW-12

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML2057xNSMx32D**	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML2057xNSMx32D**	Corbin Russwin	2
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11C422-26D	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Electromagnetic Locking Device	2011-390	Dynalock	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	1
1	Door Control Relay Interface	941-R	AES Security	
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

2: Historically when used in CACs on compound side, lock was installed restricting access from screening area

SHW-12B

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Closer	4040XP - Cush - 689	LCN	
8	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12C

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Electromechanical Combination Lock	CDX-10 (GSA Specification FF-L-2890)	KabaMas	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12D

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock	8565 x 101	Sargent and Greenleaf	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12E

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML 20932 x SEC x NSM x 32D	Corbin Russwin	
2	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11C422-26D	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
2	Cypher Lock / Keypad	CC-8521B	Moniteq	
4	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12F

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Electromechanical Combination Lock	CDX-10 (GSA Specification FF-L-2890)	KabaMas	
1	Card Reader	Various Manufacturers	-	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12G

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock set/Deadbolt - Push pull Handle (GSA Type VII)	LKM10KHLDS#	Lockmasters	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12H

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electromechanical Combination Lock	CDX-10 (GSA Specification FF-L-2890)	KabaMas	
1	Closer	4040XP-RWPA-689	LCN	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12I

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML2057xNSMx32D**	Corbin Russwin	1
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11C422-26D	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Rigid handle will be to the inside of the door

SHW-12J

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML2057xNSMx32D**	Corbin Russwin	1
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
#	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11C422-26D	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
2	Electromagnetic Locking Device	2011-390	Dynalock	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
#	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	
1	Door Control Relay Interface	941-R	AES Security	2

2	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
3	Silencers	SR64 GRY	Ives	

1: Rigid handle will be to the inside of the door
2: Hardware does not include the step-down transformer required for operation of the AES 941. The Contractor shall provide all necessary transformers.

SHW-12K

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML 20932 x SEC x NSM x 32D	Corbin Russwin	
2	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
#	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Maxum Deadbolt	11C422-26D	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
2	Cypher Lock / Keypad	CC-8521B	Moniteq	
4	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12L

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Digi Track Scramble Pad Controller	M2N or M2N 230 (for 230 VAC) or M8N or M8N 230 (specify Model 8's for applications exceeding 2 doors) New Model Number: MX-2-RM24/12/D	Hirsch	
1	Scramble Pad	DS47L or DS47L-HI (for exterior applications)	Hirsch	
1	Mounting Box	MB-8	Hirsch	
1	Card Swipe	CR12L	Hirsch	
1	Electromechanical Combination Lock	CDX-10 (GSA Specification FF-L-2890)	KabaMas	
1	Closer	4040XP-RWPA-689	LCN	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12M

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML 20932 x SEC x NSM x 32D	Corbin Russwin	
2	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
2	Cypher Lock / Keypad	CC-8521B	Moniteq	
4	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Combination Lock	8565 x 101	Sargent and Greenleaf	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-12N

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock set/Deadbolt with Push pull Handle (GSA Type ?)	LKM10KHX10S#	Lockmasters	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
1	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Cypher Lock / Keypad	CC-8521BKPD	Moniteq	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-RWPA-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Wall Stop	WS407CVX-630	Ives	
1 set	Silencers	SR64 GRY	Ives	

SHW-13

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML2067 x NSM x 32D w/ Scalp Plate 402F30	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1 ea.	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-13A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML2022 x NSM x 32D	Corbin Russwin	
2	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-13B

QUAN.	ITEM	MODEL	MFR.	NOTES
6	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Panic Exit Device	98L-630	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-14

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
1	Electromechanical Combination Lock	CDX-10 (GSA Specification FF-L-2890)	KabaMas	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	1
1	Wall Stop	WS407CVX-630	Ives	

1: At interior doors.

SHW-14A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
1	Combination Lock	8565 x 101	Sargent and Greenleaf	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-15

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-15A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-15B

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML2067 x NSM x 32D x 488F04 with outside escutcheon	Corbin Russwin	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-15C

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-15D

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
3	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11C282-26D	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-16

QUAN.	ITEM	MODEL	MFR.	NOTES
6	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
2	Flush Bolt for Metal Doors (Head and Foot Bolt) - (90 Min. Fire Rating) - Confirm Strike Plate - Pending DS LS Approval	FB458	Ives	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock with Deadbolt Extension	8565 x 104 (#9 strike)	Sargent and Greenleaf	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Stile Gasket	375CR	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-16A

QUAN.	ITEM	MODEL	MFR.	NOTES
6	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
2	Flush Bolt for Wood Doors (Head and Foot Bolt)	FB358	Ives	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Stile Gasket	375CR	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-16B

QUAN.	ITEM	MODEL	MFR.	NOTES
6	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
2	Flush Bolt for Wood Doors (Head and Foot Bolt)	FB358	Ives	
1	Lock Set	ML2067 x NSM x 32D w/ Scalp Plate 402F30	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4040XP - Cush - 689	LCN	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-16C

QUAN.	ITEM	MODEL	MFR.	NOTES
6	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
2	Flush Bolt for Wood Doors (Head and Foot Bolt)	FB358	Ives	
1	Lock Set	ML2022 x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
2	Closer	4040XP - Cush - 689	LCN	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-16D

QUAN.	ITEM	MODEL	MFR.	NOTES
6	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
2	Flush Bolt for Wood Doors (Head and Foot Bolt)	FB358	Ives	
1	Panic Exit Device	98L-630	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4040XP - Cush - 689	LCN	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	

SHW-17

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML2067 x NSM x 32D w/ Scalp Plate 402F30	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-17A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-17B

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML20906 x SEC x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-18

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL98DT-F-630-CON	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Spin Dial Cover	WPC1020D	Lockmasters	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-18A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-18B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
#	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
2	Electromagnetic Locking Device	2011-390	Dynalock	
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	1

1	Door Control Relay Interface	941-R	AES Security	1
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-18C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
2	Electromagnetic Locking Device	2011-390	Dynalock	
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	

1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	1
1	Door Control Relay Interface	941-R	AES Security	1
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
2	Sill Sweep	315CN	Pemko	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Silencers	SR64 GRY	Ives	

1: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-18D

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL98DT-F-630-CON	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Card Reader	Various Manufacturers	-	1
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Spin Dial Cover	WPC1020D	Lockmasters	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic Security (DS) approved card reader (see DS TSS Equipment List) to be provided by the technical security installation contractor

SHW-18E

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Electromagnetic Locking Device	2268-10 x DSE	Dynalock	
1	Card Reader	Various Manufacturers	-	1
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-18F

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Maxum Deadbolt	11-C402-26D	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
2	Electromagnetic Locking Device	2011-390	Dynalock	
1	Card Reader	Various Manufacturers	-	1
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2
1	Door Control Relay Interface	941-R	AES Security	2

1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections
2: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-18G

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
2	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	1
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2

1	Door Control Relay Interface	941-R	AES Security	2
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections
2: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-18H

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	RX-QEL-98NL-F-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	1
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	
1	Toggle Switch	DPST	Generic	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	

-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2
1	Door Control Relay Interface	941-R	AES Security	2
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
2	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
2	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

1: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections
2: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-19

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
-	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
2	Magnetic Switch	MSS-312C	Magnasphere	
1	Spin Dial Cover	WPC1020D	Lockmasters	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Stile Gasket	375CR	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-19A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
-	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
2	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	
2	Sill Sweep	315CN	Pemko	
1 Set	Stile Gasket	375CR	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-19B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Spin Dial Cover	WPC1020D	Lockmasters	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Closer	4040XP-SHCUSH-689	LCN	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-19C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	98L-BE-630	Von Duprin (Allegion)	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Spin Dial Cover	WPC1020D	Lockmasters	
1	Closer	4040XP-SHCUSH-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	332CR	Pemko	
1	Sill Sweep	315CN	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-19D

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	98L-BE-630	Von Duprin (Allegion)	
-	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
#**	Certified Forced Entry Lock with Exterior Keyed Cylinders	Model and quantity to match certified / rated door	Various Manufacturers	
#**	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
#**	Interchangeable Core	320201H-26	Medeco	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Spin Dial Cover	WPC1020D	Lockmasters	
2	Closer	4040XP-SHCUSH-689	LCN	
2	Magnetic Switch	MSS-312C	Magnasphere	
1	Door Coordinator	Provide by Door Manufacturer and To Work with Door	Various Manufacturers	
1 Set	Weather Stripping	332CR	Pemko	2
1	Sill Sweep	315CN	Pemko	2
1 Set	Stile Gasket	375CR	Pemko	1
1 Set	Silencers	SR64 GRY	Ives	

1: At interior doors.
2: At exterior doors.

SHW-20

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Mechanical Pushbutton Combination Lock	L(hand)1021M-26D-41	DormaKaba (Simplex)	
1	Interchangeable Core	320201H-26	Medeco	
1	Electric Strike	310-2-3/4x24DC	Folger Adam	
1	Emergency Switch	RCI-904EB	Rutherford Controls	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-21

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Passage Set	ML2010 x NSM x 32D	Corbin Russwin	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-21A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Lock Set	ML2020 x NSM x 32D	Corbin Russwin	
1 Set	Silencers	SR64 GRY	Ives	
1	Wall Stop	WS407CVX-630	Ives	

SHW-22

QUAN.	ITEM	MODEL	MFR.	NOTES
1	Electromechanical Gate Lock	GL1-FL	Securitron	
1	Mounting Bracket	N/A when Mortised; otherwise: FMK-SW OR FMK-SL as determined by gate type	Securitron	1
1	Mortise Cylinder Housing w/ Adams Rite Cam	320275-26-Z02 w/ tapered collar 94-0188-26	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Mortise Spacer	1/4, 3/8, 1/2 as determined by Mortice Cylinder Length	Medeco	
1	Gate Closer	As Required by gate design	Gate Vendor	
1	Gate Stop	As Shown in Design	By Design or Gate Vendor	

1: When lock is mortised, bracket is not required

SHW-22A

QUAN.	ITEM	MODEL	MFR.	NOTES
1	Electric Deadlatch w/ Std. Strike	Steel Hawk 4300	Adams Rite	
1	Strike	4901-02	Adams Rite	1
2	Mortise Cylinder Housing w/ Adams Rite Cam	320275-26-Z02 w/ tapered collar 94-0188-26	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Mortise Spacer	1/4, 3/8, 1/2 as determined by Mortice Cylinder Length	Medeco	
1	Gate Closer	As Required by gate design	Gate Vendor	
1	Gate Stop	As Shown in Design	By Design or Gate Vendor	

1: Specify for radius gates or double gates

SHW-22B

QUAN.	ITEM	MODEL	MFR.	NOTES
1	Manual Mechanical Gate Lock	4900	Adams Rite	
2	Mortise Cylinder Housing w/ Adams Rite Cam	320275-26-Z02 w/ tapered collar 94-0188-26	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Mortise Spacer	1/4, 3/8, 1/2 as determined by Mortice Cylinder Length	Medeco	
1	Gate Closer	As Required by gate design	Gate Vendor	
1	Gate Stop	As Shown in Design	By Design or Gate Vendor	

SHW-22C

QUAN.	ITEM	MODEL	MFR.	NOTES
1	Manual Mechanical Gate Lock	MS1850S-x5x	Adams Rite	
2	Mortise Cylinder Housing w/ Adams Rite Cam	320275-26-Z02 w/ tapered collar 94-0188-26	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Mortise Spacer	1/4, 3/8, 1/2 as determined by Mortice Cylinder Length	Medeco	
1	Weldable Box	K-BXA/R-11/2	Keedex	
1	Gate Closer	As Required by gate design	Gate Vendor	
1	Gate Stop	As Shown in Design	By Design or Gate Vendor	

SHW-23

QUAN.	ITEM	MODEL	MFR.	NOTES

SHW-24

QUAN.	ITEM	MODEL	MFR.	NOTES

SHW-25

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Panic Exit Device	QEL-98NL-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Closer	4040XP - Cush - 689	LCN	
1	Latching Panic Exit Saddle	177AV	Pemko	
1	Door Bottom Sweep	345A36	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-25A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Lock Set	ML2067 x NSM x 32D	Corbin Russwin	
1	Mortise Cylinder Housing & tailpiece	320275-26-Z00	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
-	Certified Forced Entry Lock	Model and quantity to match certified / rated door.	Various Manufacturers	
1	Closer	4040XP-SHCUSH-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Latching Panic Exit Saddle	177AV	Pemko	
1	Door Bottom Sweep	345A36	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-26

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Hinge - NRP (non-removable pin)	BB1199-32D NRP 4-1/2 INCH x 4-1/2 INCH	Hager	
1	Panic Exit Device	QEL98TP-630-CON	Von Duprin (Allegion)	
1	Rim Cylinder	320475V-Y32 w/ Tapered Cylinder Collar 94-0188-26.	Medeco	
1	Interchangeable Core	320201H-26	Medeco	
1	Maxum Deadbolt	11C422-26D	Medeco	
2	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	EPT2-689-CON-3 OR OTHER DOS approved	Von Duprin (Allegion)	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Latching Panic Exit Saddle	177AV	Pemko	
1	Door Bottom Sweep	345A36	Pemko	
1 Set	Silencers	SR64 GRY	Ives	

SHW-31A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP-CUSH-689-SRI	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-31B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR RTE	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	2
1	Door Control Relay Interface	941-R	AES Security	2
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.
2: Hardware does not include the step-down transformer required for operation of the AES 941. The contractor shall provide all necessary transformers.

SHW-31C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
-	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-32A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR RTE	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Card Reader	Various Manufacturers	-	2
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	
1	Door Control Relay Interface	941-R	AES Security	
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

2: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-32B

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
1	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
-	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	
1	Door Control Relay Interface	941-R	AES Security	
1	Door Control Module	941-M	AES Security	
2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-32E

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-32C

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-32D

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
1	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-33A

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LL2-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-33B

QUAN.	ITEM	MODEL	MFR.	NOTES
-	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR RTE	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-33C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP4-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Spin Dial Cover	WPC1020D	Lockmasters	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-33D

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP4-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-33E

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LL4-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP-SHCUSH-689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-34A

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Multi-lock Device	XP9-000	DOS Multi-Point Lock	1
2	Closer	4414ME-REGARM-689-handing-24VDC	LCN	
1	Door Coordinator	(NO MODEL NUMBER) -32	Various Manufacturers	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-34B

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4414ME-REGARM-689-handing-24VDC	LCN	
1	Door Coordinator	(NO MODEL NUMBER) -32	Various Manufacturers	
1	Electric Power Transfer	EPT-10 x SP28	Von Duprin (Allegion)	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1 ea.	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-34C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR RTE	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4414ME-REGARM-689-handing-24VDC	LCN	
1	Door Coordinator	(NO MODEL NUMBER) -32	Various Manufacturers	
1	Card Reader	Various Manufacturers	-	2
1	Electric Power Transfer	EPT-10 x SP28	Von Duprin (Allegion)	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1 ea.	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.
2: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-35A

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Multi-lock Device	LL4-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4040XP - Cush - 689	LCN	
1	Door Coordinator	(NO MODEL NUMBER) -32	Various Manufacturers	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Spin Dial Cover	WPC1020D	Lockmasters	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-35B

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Multi-lock Device	LL4-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4040XP - Cush - 689	LCN	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-35C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Multi-lock Device	LP4-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4040XP - Cush - 689	LCN	
1	Door Coordinator	(NO MODEL NUMBER) -32	Various Manufacturers	
1	Combination Lock with Deadbolt Extension	8565 x 102	Sargent and Greenleaf	
1	Spin Dial Cover	WPC1020D	Lockmasters	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-35D

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Certified Head and Foot Bolts	Model and quantity to match certified/rated door.	Various Manufacturers	
1	Multi-lock Device	LP4-100	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
2	Closer	4040XP - Cush - 689	LCN	
1	Door Coordinator	(NO MODEL NUMBER) -32	Various Manufacturers	
2	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-36A

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	XP9-000-DE	DOS Multi-Point Lock	1
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Fire Door Control Module	AES-945	AES Security	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-36B

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	DP5-001-MBR DE RTE	DOS Multi-Point Lock	1
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Fire Door Control Module	AES-945	AES Security	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-36C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP2-101-MBR DE RTE	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1	Fire Door Control Module	AES-945	AES Security	
1	Recessed Mount Key Control Lockbox with Combination Lock	4440-GCI, 4450	Knox or DS Approved Equal	2
1	Toggle Switch	DPST	Generic	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.
2: MODEL 4450 IS FOR RECESSED CONDITION. MODEL 4440 SHUOLD BE USED WHEN SURFACED MOUNTED. BOTH MODELS SHOULD BE INSTALLED WITH TWO TAMPER SWITCHES

SHW-37A

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP4-101- MBR	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	
1	Door Control Relay Interface	941-R	AES Security	
1	Door Control Module	941-M	AES Security	
1 or 2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-37B

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	XP9-001-MBR	DOS Multi-Point Lock	1
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	
1	Door Control Relay Interface	941-R	AES Security	
1	Door Control Module	941-M	AES Security	
1	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-37C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LP4-101-MBR RTE	DOS Multi-Point Lock	1
1	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
1	Interchangeable Core	320201H-26	Medeco	
1	Pneumatic Auto-Equalizer	4840-689	LCN	
1	Cover	4840-72MC-689	LCN	
1	Stop	4840-3077CNS-689	LCN	
1	Pneumatic Transfer Hinge	4840-460-689	LCN	
1	Pneumatic Tubing	7910-925-length	LCN	
1	Door Control Package	7981ES or 7982ES (for two doors)	LCN	
1	Door Control Relay Interface	941-R	AES Security	
1	Door Control Module	941-M	AES Security	
1 or 2	Wall Mounted Switches	625BLH-DP-SF-626	Schlage	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Card Reader	Various Manufacturers	-	2
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

2: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-38A

QUAN.	ITEM	MODEL	MFR.	NOTES
3	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LL8-303-MBR RTE	DOS Multi-Point Lock	1
2	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
2	Interchangeable Core	320201H-26	Medeco	
1	Cypher Lock / Keypad	CC-8521B	Moniteq	
1	Cypher Lock / Keypad	CC-8521BKPD	Moniteq	
2	Rechargable Batteries 7AH	CC-BATT x 12 VDC x 7AH	Moniteq	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SHW-38B

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LL8-303-MBR RTE	DOS Multi-Point Lock	1
2	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
2	Interchangeable Core	320201H-26	Medeco	
1	Electric Power Transfer	DOS Approved	DOS Approved	
1	Closer	4040XP - Cush - 689	LCN	
2	Card Reader	Various Manufacturers	-	2
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.
2: Diplomatic security (DS) approved card reader shall be provided by technical security installation contractor; see division 28 sections

SHW-38C

QUAN.	ITEM	MODEL	MFR.	NOTES
#	Certified Forced Entry Hinge	Model and quantity to match certified/rated door	Various Manufacturers	
1	Multi-lock Device	LL7-300	DOS Multi-Point Lock	1
2	Mortise Cylinder Housing & tailpiece	Cylinder per lock vendor	By Multi-Point Lock Vendor	
2	Interchangeable Core	320201H-26	Medeco	
1	Closer	4040XP - Cush - 689	LCN	
1	Magnetic Switch	MSS-312C	Magnasphere	
1 Set	Weather Stripping	Weather Stripping per certified door model	By Design or Door Vendor	
1	Threshold	Threshold per certified door model	By Design or Door Vendor	

1: Each door manufacuter will provide their own approved Multi-Point locking device. This generic number is to establish the functions and features that the lock for this SHW set is intended to comply with.

SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

The following security hardware schedule parameters are provided as general guidance. The designer is responsible to fully develop the security hardware schedules according to the RFP package, including the OBO Building Code. The schedules in this section utilize the room descriptions found in the OBO Space Requirements Program (SRP) and respective Space Requirements Program Modules (SRP-Ms), and are meant to serve as a tool, or guide, to assist the designer in the development of the actual door hardware schedule or schedules. They are organized according to operational function with the SRP-M room description used to identify their locations. This means that in some cases the SRP descriptions will be divided so that the doors will be grouped where they are found instead of being grouped solely within their functional prefixes (i.e., building common spaces (prefix Z) will include some IRM (prefix G) and RSO (prefix E) functional spaces). When more than one door provides access to a particular room, or when the SRP-M room description does not fully describe a door location, additional information to describe the location has been provided. Doors included in these schedules apply to new office buildings (NOBs), new office annexes (NOXs), compound access control facilities (CACs) and new embassy compound (NEC) housing (MSGR and CMR). Post Communication Center (PCC) hardware is covered separately in the classified criteria.

When preparing the door hardware schedule, the designer shall coordinate/design/update the following: acoustic protection, stops, finishes (for both hardware and doors), thresholds, weather stripping, seals, sweeps, DOS Code (coordinated with required fire protection), degree opening setting for door closers, verifying/selecting models when alternatives are possible, etc. The "Swing" column, along with other information typically found on a door schedule, have been omitted for clarity, since these items are ultimately dictated by the design. SRP-M descriptions are intended to be used for planning purposes only and shall not be included in any post specific schedule. Only door mark number and room numbers are to be used in post specific schedules. Lastly, please note that all forced entry and ballistic resistant (FEBR) doors are to have a reverse bevel swing and the designer is required to use DOS security hardware terminology for swing and FEBR descriptions.

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A - NEW OFFICE BUILDING AND NEW OFFICE ANNEX (NOB & NOX)
B - PEDESTRIAN/CONSULAR CAC (PEDESTRIANS ONLY)
C - MAIN ENTRANCE CAC (VEHICLE/PEDESTRIAN)
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A - NEW OFFICE BUILDING & NEW OFFICE ANNEX (NOB & NOX)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
A-01 Executive Section [Adj. Diag. SG-EXE01]						
WA010	Executive Section Suite	Suite Entry	2111	SHW-12C		
OF010	Chief of Mission Office (COM)	Office Entry	2111	Privacy Set		See 087135, HW Hardware
OF010	Chief of Mission Office (COM)	Back Door	2111	SHW-15D or SHW-11B		Location determines hardware type: (i.e. SHW-11B to another suite when re-entry not required and SHW-15D when exiting/reentry control is required)
OF009	Deputy Chief of Mission (DCM)		2111	Privacy Set		See 087135, HW Hardware
B-02 Political Section						
Suite	Political Section Suite	Suite Entry	2111	SHW-12C		
Suite	Political Section Suite	Back Door	2111	SHW-11B		This suite does not typically have a back door, but may be added if required by fire egress requirements.
OF006	Political Chief		2111	Privacy Set		See 087135, HW Hardware
C-01 Economic Section						

A - NEW OFFICE BUILDING & NEW OFFICE ANNEX (NOB & NOX)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
Suite	Economic Section Suite	Suite Entry	2111	SHW-12C		
Suite	Economic Section Suite	Back Door	2111	SHW-11B		This suite does not typically have a back door but may be added if required by fire egress requirements.
	Economic Chief		2111	Privacy Set		See 087135, HW Hardware
D-01 and D-02 Office D						
CR023	Office D	Suite Entry	2111	SHW-12N		Suite entry door is typically the interior door in a vestibule.
CR023	Office D	Vestibule Suite Entry	2111	SHW-7C or SHW-7B		Used only in conjunction with a suite entry door as the outer door
CR023	Office D	Back Door	2111	SHW-12G		If this door is identified as a required fire egress, per the IFC, additional signage may be required with regards to operation of the deadbolt.
CR023	Office D	Vestibule Back Door	2111	SHW-7C or SHW-7B		Used only in conjunction with a suite back door as the outer door.
OF036	Office D Chief		2111	Privacy Set		See 087135, HW Hardware
BS081, BS082,BS	Power Equipment Room		2111	SHW-15		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
083, BS084						
ST097, ST098	Secure Safe/Pouch Room		2111	SHW-13		Room within the suite
ST134, ST135	Storage Controlled	Near Service Entry	2111 or 3111	SHW-11		
WR084	Disintegrator Room		2111	SHW-16A	Provide sound insulation/ Treatment	
E. Diplomatic Security E-01 Regional Security Office (RSO) [Adj. Diag. SG-RSO01]						
Suite	Regional Security Office (RSO)	Suite Entry	2111	SHW-12C		
Suite	Regional Security Office (RSO)	Back Door	2111	SHW-11B		This suite does not typically have a back door but may be added if required by fire egress requirements.
OF006	Regional Security Officer		2111	Privacy Set		See 087135, HW Hardware
WR053	ID Picture Area		2111	SHW-15C		Only when outside of CAA suite, otherwise no special hardware required when inside of a CAA suite
ST129	Storage		2111	SHW-13		
WR106	Ready Room	Within suite	2111	SHW-15		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
OF014	RSO FSNI Interview Room		2111	Privacy Set		Typically located in GWA outside RSO suite See 087135, HW Hardware
E-02 Engineering Services Office (ESO)						
IT009,ST 141	E-11 Storage & Workshop for SEO	Within RSO Suite	2111	SHW-11		Only when there is no ESO or ESC at Post
Suite	Engineering Services Office	Suite Entry	2111	SHW-12C		
Suite	Engineering Services Office	Back Door	2111	SHW-15B		This suite does not typically have a back door but may be added if required by fire egress requirements.
OF006	Security Engineering Officer (SEO)		2111	Privacy Set		See 087135, HW Hardware
OF034	Security Technical Specialist					
ST030,ST 048,ST04 9, ST050	Vault		2133 and 2111	SHW-9 and SHW10		Vault door: 2133 Day Door: 2111
E-03 Engineering Services Center (ESC) [Adj. Diag. ESC01]						
Suite	Engineering Services Office	Suite Entry	2111	SHW-12C		
Suite	Engineering Services Office	Back Door	2111	SHW-15B		This suite does not typically have a back door but may be added if

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
						required by fire egress requirements.
OF006	Officer In Charge		2111	Privacy Set		See 087135, HW Hardware
ST023, ST025	Vault		2133 and 2111	SHW-9 and SHW10		Vault door: 2133 Day Door: 2111
E-06 Marine Security Guards (MSG)						
WR060, WR062	Marine Security Guard Suite	Suite Entry	2111	SHW-11A or SHW-15C		Specify SHW-15C for small (5-6 man detachments) or at existing Post with the approval of COR thru OBO/SM physical security engineer
WR060, WR062	Marine Security Guard Suite	Back Door	2111	SHW-11B		This suite does not typically have a back door but may be added if required by fire egress requirements.
OF049, OF033	Detachment Commander		2111	Privacy Set		See 087135, HW Hardware
WR012,WR013, WR015	React Room	Within MSG Suite	----	----		No special Hardware required.

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
WR012,WR013, WR015	React Room	Stand Alone React Room	2111	SHW-11A or SHW-15C		Specify SHW-15C for small (5-6 man detachments) or at existing Post with the approval of COR thru OBO/SM physical security engineer
F. Post Communication Center (PCC)						
See Classified Criteria						
G. Information Resource Management (IRM)						
G-01 IRM Office						
Suite	IRM Suite		2111	SHW-7C		
IT006	Staging - PC Equipment		2111	SHW-14A		
ST071	Storage		2111	SHW-14A		
IT022	Computer Room(s) - UCR		2111	SHW-11		
IT022	JUCR – Join Unclassified Computer room	Entry	2111	SHW-11		Typically access from corridor outside of IRM suite
IT022	JUCR – Join Unclassified Computer room	Door to IRM suite	2111	SHW-12M		Secondary access in addition to primary door.
	PBX,TSEF,MTS					See Building systems section
G-02 Telephone & Radio Support						
IT005, IT006	Telephone Workshop		2111	SHW-15A		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
IT005, IT006, IT009, IT068	Radio Workshop		2111	SHW-15A		
ST063, ST071	Storage		2111	SHW-13		
IT028	Radio Repeating Equipment - Controlled		2111	SHW13		
IT028	Storage, Radio Rm for DES Radios		2111	SHW13		
G-03 Mail Room [Adj. Diag. SG-MLR02]						
Suite, MH004, MH010, MH011	Mail Room	Main Entry to Corridor	3111 or 2111	SHW16 or SHW-15A		Typically a door pair. In single door applications use SHW-15A
WR027, WR028	Mail Room	Access to Repro-duction / Distribution Room	3111 or 2111	SHW-15A		
H. Management Sections H-01 though H-03Management Office						
SV009	Cashier Booth		3111 or	SHW-15A		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
			2111			
	Storage (Controlled)		3111 or 2111	SHW-13 or SHW-15A		Frequency of use determines hardware
WR058	Computer/ Equipment Support Area		3111 or 2111	SHW-13 or SHW-14A		Coordinate use/application with OBO
H-05 Health Unit [Adj. Diag. SG-MED03]						
HC013, HC035, HC036	Health Unit	Suite Entry	2111	SHW-12B	A kick stand hold open may be added to this door	
Suite	**Health Unit**	Back Door	2111	SHW-15B or SHW-15D		This suite does not typically have a back door but may be added if required by fire egress requirements or access requirements. Location determines hardware type: (i.e., SHW-15B to another suite when re-entry not required and SHW-15D when exiting/reentry control is required)
HC006, HC033, HC034	Pharmacy		2111	SHW-11A		
J. Public Affairs Office						

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
J-06 American Center or Information Resource Center [Adj. Diag. SG-MPR02]						
Suite	American Center (AC) or American Space	Lobby to AC or Exterior entrance	1123	SHW-1B or SHW 5A, SHW 5B or SHW-37A, SHW-37C		SHW 5A is used when access is from the perimeter and has its own security screening. SHW-5B is used at large AC in addition to SHW-5A. SHW 1B is used when screening is performed before entering AC and access control is required. For exterior blast-rated building locations, use SHW-37A and SHW-37B
Suite	American Center Staff access to GWA	Entry door to GWA	2123	SHW-2G		
Suite	Information Resource Center (IRC) [Historical application]	Main Lobby to IRC (Public Entry)	1123	SHW 1B		IRC is typically not used in new construction. Application should be coordinated with OBO/SM
Suite	Information Resource Center [Historical application]	Egress/ Entry door to GWA	2141	SHW-2G		IRC is typically not used in new construction. Application should be coordinated with OBO/SM
K. Consular Section [Adj. Diag. SG-CON01]						
Suite	Consular Office Staff Area	Primary Suite Entry	3111 or 2111	SHW-7		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
Suite	Consular Office Staff Area	Secondary Suite Entry	3111 or 2111	SHW-7C or SHW-7B		Used when more than one access is required. Use SHW7B when egress requirements require panic bar egress.
OF014, OF033	Consular Officer	Chief	3111 or 2111	Privacy Set		See 087135, HW Hardware
SV021	Cashier(s) service area		3111 or 2111	SHW-15A		
ST137	Storage, ACS Estate		3111 or 2111	SHW-13		
MC. Narcotics Affairs Sections (NAS)						
Suite	Narcotics Affairs Sections (NAS)	Suite Entry	2111	SHW-12C or HW Set		When located in the CAA, specify SHW-12C. No special security hardware when located outside of the CAA.
Suite	Narcotics Affairs Sections (NAS)	Back Door	2111	SHW-11B or HW Set		This suite does not typically have a back door but may be added if required by fire egress requirements. No special security hardware when located outside of the CAA.

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	Chief		2111	Privacy Set		See 087135, HW Hardware
P-01 Department of Defense Offices (DOD)						
Suite CR023	Defense Attaché Suite	Suite Entry	2111	SHW-12H		
Suite, CR023	Defense Attaché Suite	Back Door	2111	SHW-12G		This suite does not typically have a back door but may be added if required by fire egress requirements.
OF043	Defense Attaché		2111	Privacy Set		See 087135, HW Hardware
ST100	Storage Secure DAO Closet		2111	SHW-14 or HW		Accessed from outside suite HW when not secure storage
IT080	Systems Room		2133 and 2111	SHW-9 and SHW-10A		Vault door: 2133 Day Door: 2111
P-04 Security Assistance Office (SAO) (ODC or MLO)						
Suite	Security Assistance Office (SAO) (ODC or MLO)	Suite Entry	2111	SHW-12C or SHW-15C		When located in the CAA, specify SHW-12C. Specify SHW-15C when suite is not located within the CAA.
Suite	Security Assistance Office (SAO) (ODC or MLO)	Back Door	2111	SHW-11B		This suite does not typically have a back door but may be added if

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
						required by fire egress requirements.
IT029, IT030, IT031	Systems Room		2111	SHW-11		
Q. Department of Justice Office (DOJ) Q-03 Drug Enforcement Agency (DEA)						
Suite	Drug Enforcement Agency (DEA)	Suite Entry	2111	SHW-12C or SHW-15A		When located in the CAA, specify SHW-12C. Specify SHW-15A when suite is not located within the CAA.
Suite	Drug Enforcement Agency (DEA)	Back Door	2111	SHW-11B		This suite does not typically have a back door but may be added if required by fire egress requirements.
OF006	DEA Attaché		2111	Privacy Set		See 087135, HW Hardware
IT033	Systems Room		2133 and 2111	SHW-9 and SHW-10A	Provide sound insulation/ Treatment when within suite	Vault door: 2133 Day Door: 2111
Q-05 Department of Justice (FBI/LEGAT)						
Suite CR023	FBI/LEGAT	Suite Entry	2111	SHW-12C		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
Suite CR023	FBI/LEGAT	Back Door	2111	SHW-11B		This suite does not typically have a back door but may be added if required by fire egress requirements.
OF036	FBI (Chief)		2111	Privacy Set		See 087135, HW Hardware
IT038	Systems Room		2111	SHW-11		
ST146	Evidence Storage Room		2111	SHW-11A		LAA space
R-02 Department of Homeland Security						
Suite	Bureau Of Citizenship & Immigration Services (USCIS)	Suite Entry	2111	SHW-15A		
Suite	Bureau Of Citizenship & Immigration Services (USCIS)	Back Door	2111	SHW-11B or SHW-15D		This suite does not typically have a back door but may be added if required by fire egress requirements or access requirements. Location determines hardware type: (i.e., SHW-15B to another suite when re-entry not required and SHW-15D when exiting/reentry control is required)
OF033	Chief		2111	Privacy Set		See 087135, HW Hardware

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
BS128	Systems Room		2111	SHW-11	Provide sound insulation/ Treatment when within suite	Only if systems rack is not in the JUCR room
R-04 Customs and Boarder Protection						
BS128	Systems Room		2111	SHW-11		Only if systems rack is not in the JUCR room
R-05 US Secret Service						
Suite	US Secret Service	Suite Entry	2111	SHW-12C		
Suite	US Secret Service	Back Door	2111	SHW-11B		This suite does not typically have a back door but may be added if required by fire egress requirements.
OF033	Officer - Chief		2111	Privacy Set		See 087135, HW Hardware
BS128	Systems Room		2111	SHW-11	Provide sound insulation/ Treatment when within suite	Only if systems rack is not in the JUCR room

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
OF033	Commission Director - Regional Director		2111	Privacy Set		See 087135, HW Hardware
S-01 Department of Agriculture						
BS128	P-6 and P-16 Systems Room		3111 or 2111	SHW-11	Provide sound insulation/ Treatment when within suite	Only if systems rack is not in the JUCR room
T-01 Department of Commerce						
BS128	Systems Room		3111 or 2111	SHW-11	Provide sound insulation/ Treatment when within suite	Only if systems rack is not in the JUCR room
T-02 Foreign Commercial Library						
CO001 CO012	Foreign Commercial Library	Main Lobby/ Public Entry	1123	SHW-1B		There are some cases that this space is Not located off of lobby; in that case, coordinate hardware and DOS rating to match location/ SRP requirements. COR approval based on input of OBO/SM

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
						physical security engineer of hardware/DOS code is required.
W. Broadcast Open Source Center (formally FBIS)/VOA/IBB						
Suite	Broadcast Open Source Center/VOA/IBB	Suite Entry	2111	SHW-15A		
Suite	Broadcast Open Source Center /VOA/IBB	Suite Exit	2111	SHW-15A		
	Computer Room		2111	SHW-11		
X. Shared Office Support – Post Facility X-05 Shared/Other						
CR031	Type II Conference room Vestibule		2111	SHW-11		
CO022 CO023 CO040	Conference Rooms -Type II			Passage Set		No SHW set required – must have vestibule
CO029	Conference Room (Non-Type II) within CAA	Within CAA Suite	2111	Passage Set		No SHW set required
WR010	Training, Computer terminals		3111 or	SHW-15		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
			2111			
	Training, Computer terminals within the CAA	Within CAA Suite	2111	----		No SHW set required
	Training, Computer terminals within the CAA	Corridor to Room	2111	SHW-11		
X-05 Growth Workstations						
WS017	Workstation, Growth – CAA (When an enclosed office)	Within CAA Suite	2111	----		No SHW set required
WS017	Workstation, Growth – CAA (When an enclosed office)	Corridor to Room	2111	SHW-11		
WS017	Workstation, Growth – CAA Suite	Suite Entry	2111	SHW-12C or SHW-11		Use SHW-11 for small suites of up to 3 or 4 individuals
	Workstation, Growth – non CAA					No SHW set required
Y. Support Functions Y-03 Multipurpose Room [Adj. Diag. SG-MPR02]						
CO002, CO008, CO015, CO016	Multipurpose Room	Public Entry From Lobby	1123	SHW-1B, or SHW-1B and SHW-5D		SED's and large multipurpose rooms use SHW-1B and SHW-5D (Two doors – one in and one out)
CO002, CO008, CO015, CO016	Multipurpose Room - Staff access to GWA	Public to GWA	2123	SHW-2F		

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	PAA conference Room (Greater than 23 SQM	Lobby Entrance	1123	SHW-1B		
	PAA conference Room (Greater than 23 SQM	Staff access to GWA	2123	SHW-2G		
	PAA conference Room (Less than 23 SQM	Lobby Entrance	2111			No SHW required when less than 23 SQM
	COM Protective Detail Suite	Lobby to suite	2111	SHW-7A		When in PAA
	COM Protective Detail Suite	GWA	2111			When in GWA No SHW hardware
Y-04 Commercial Bank						
SV002	Commercial Bank	Public/ Suite Entry	3111 or 2111	SHW-15A		
Z. Building Common						
WA006, WA007	Z-02 Main Entrance (exterior hardline)	Lobby / Waiting	1123	SHW-5A or SHW-5E or SHW-37A or SHW-37C		Specify SHW-5E if DS approved card reader is required. For exterior blast-rated building locations, use SHW-37A and SHW-37C
WA006, WA007	Z-02 Main Exit (exterior hardline)	Lobby / Waiting	1123	SHW-5B or SHW-37B		For exterior blast-rated building locations, use SHW-37B

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	Z-02 Main Entrance (exterior hardline) Lock and Leave Applications	Lobby / Waiting	1123	SHW-2D, SHW-2A, or SHW-5E or SHW-32A, SHW-32B, SHW-37C		Specify SHW-2A when compliance with accessibility is not required. Specify SHW-5E when SMSe and card reader is required. For exterior blast-rated building location use 32A, 32B, or 37C
WA001	Main Entrance Annex or GSO Building (exterior hardline)	Lobby / Waiting	1123	SHW-2D, SHW-2B, or SHW-5E SHW-32A, SHW-32B, or SHW-37C		SHW-2B and SHW-2C are sometimes used in existing building applications or very small annexes. Coordinate selection with COR based on input from OBO/SM physical security engineer. Specify SHW-5E when SMSe and card reader is required. For exterior blast-rated building location use 32A, 32B, or 37C
	Z-02 Main Entrance (interior hardline)	Lobby to GWA	1123	SHW-1C		
	Z-02 Main Entrance (interior hardline) Lock and Leave Applications	Lobby to GWA	1123	SHW-18B or SHW-18F		Specify SHW-18F when SMSe and card reader is required

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	Main Entrance Annex (interior hardline)	Lobby to GWA	1123	SHW-1B, SHW-2AD, SHW-2D, or SHW-2E		Specify SHW-2D or SHW-2A when there is no receptionist/guard assigned to control the interior hardline. SHW-2A when compliance with accessibility is not required. Not all Annexes have interior hardline or control door. Exterior keyed FEL's are also sometimes provided; coordinate with COR based on input from OBO/SM physical security engineer. Specify SHW-2E when SMSe and card reader is required.
SC001 SC002	E-06 Guard Post #1 (MSG) and Guard Post # 2		1123	SHW-3		½ Vision; No change in hardware when Post 1 or Post 2 is NOT staffed by an MSG
IT017	G-02 EC Room		2111 or	SHW-13,		Use SHW-17 when 24/7 AC is NOT provided. Specify SHW-17B

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
			3111	SHW-17, or SHW-17B		when SMSe and card reader is required.
IT017	G-02 EC Room – Lock and Leave Applications		2111 or 3111	SHW-17A or SHW-17B		Specify SHW-17B when SMSe and card reader is required.
CO030	E-01 Interview Room	Main Lobby to Interview Room	2111 or 3111	SHW-12A	Provide sound insulation/ treatment	Door should be reverse bevel and swing into the Lobby.
CO031	E-01Interview Room	Interview Room to Anti-room	2123	SHW-2G	Provide sound insulation/ treatment	Anti-room is the secure side of the door.
CO031	E-01 Interview Room	Anti-room to GWA	2111 or 3111	SHW-11	Provide sound insulation/ Treatment	Anti-room is the secure side of the door.
EX020	E-01 Consular Entrance	Building Exterior to Security Screening	1123	SHW-5A or SHW-37A	Add Keyed FELs to one door into the consular waiting.	For exterior blast-rated building location use SHW-37A
EX020	E-01 Consular Exit (when adjacent to entrance door and guard screening desk)	Security Screening to Building Exterior	1123	SHW-5B or SHW-37B		For exit only door when required by occupancy load. For exterior blast-rated building location use SHW-37B

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
						Often used as an outbound lane adjacent to inbound lane at larger consular sections to alleviate congestion at screening area.
EX020	E-01 Consular Exit (when remotely located from the guard screening desk)	Security Screening to Building Exterior	1123	SHW-8 or SHW-36A		For exit only door when required by occupancy load. For exterior blast-rated building location use SHW-36A
EX020	E-01 Consular Entrance	Main Lobby to Security Screening/ Waiting Area	1123	SHW-1D or SHW1B		Specify SHW-1B only when there is NO consular access/entry direct from the exterior (compound).
WA005	E-01 Service Entrance	Building Exterior/ Loading Dock to Security Screening	1123	SHW-6A, SHW-6, SHW-34B, or SHW-34A		Use SHW-6A when the entry doubles as an employee entry (typical for an SED). ½ vision top in SHW-6A applications. For exterior blast-rated building location use SHW-34B or SHW-34A. Use SHW-34B when also an entry

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
WA005	E-01 Service Entrance	Security Screening to GWA/ Employee Entry	1123	SHW-6A or SHW-34B		½ vision top; For exterior blast-rated building location use SHW-34B
ST029, ST037, ST038, ST051	F-05 Pouch Vault	Near Service Entry	2133 and 2111	SHW-9 and SHW-10		Vault door: 2133 Day Gate: _111
ST134, ST135	D-02 Storage, Controlled	Near Service Entry	2111	SHW-14		
	Limited Access Area (LAA) Lock and Leave applications	GWA to LAA	2141	SHW-18, SHW-18A, SHW-18C, SHW-18D, SHW-18E, or SHW-18F		Configuration of the door determines hardware. Specify SHW-18D, 18E, or 18F when SMSe and card reader is required.
BR016	H-29 Driver's Lounge (when separated by a hardline from the building)	Building Exterior to Lounge	1123	SHW-1A, SHW-2C,	Exterior FEL's added when	Use SHW-2C for very small or existing facilities with COR approval based on OBO/SM

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SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
				SHW-32C, or SHW-32D	only one access point	physical security engineer input. When entry is located within service entry lobby (special case), no SHW hardware required. Exterior keyed FEL's are sometimes provided; coordinate this requirement with COR using physical security engineer input. 1A –add Exterior Keyed FEL For exterior blast-rated building location use 32C, 32D
ALL	Circulation, Community Areas or any Space Requiring an Emergency Exit(s)	Building Exterior Hardline	1123 or 2123	SHW-8 or SHW-36A		For exterior blast-rated building location use SHW-36A
	Circulation, Community Areas or any Space Requiring an Emergency Exit (Lock and Leave Bypass Door)	Building Exterior to GWA	1123 or 2123	SHW-8B or SHW-36C		Typically one emergency exit specified with this door hardware, all other emergency exits should have SHW-8 hardware. For exterior blast-rated building location use SHW-36C
	Circulation or any Space that Provides Primary Access to the CAA Buffer Area	GWA access to CAA Buffer	2111	SHW-7F or SHW-7H		Requires wall-mounted telephone and phone list in vestibule, adjacent to door. Use 7H when door is in-swinging.
	Circulation, Stairwell or any Space that Provides Secondary Access to the CAA Buffer	GWA Rear access to CAA Buffer	2111	SHW-7F, or SHW-7H		Requires wall-mounted telephone and phone list in vestibule,

A - NEW OFFICE BUILDING & NEW OFFICE ANNEX (NOB & NOX)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
						adjacent to door. Use 7H when door is in-swinging.
	Primary Access to the CAA Buffer via a double door		2111	SHW-16A		Special case: Specified only when remote access and card reader is not required, often located on the 3rd floor of mid-sized office. In addition, a wall-mounted telephone and phone list is provided adjacent to the door.
	Building Safe Area (Other than or in addition to the PCC)		2123 or 1123	SHW-4, SHW-4A, or SHW-4B		Specify at existing posts or when only a safe area is required. Glazing is not desired and generally limited to 100mm x 500mm opening. SHW set is determined by the secondary use of the space (i.e. specify SHW-4 for a regular office space, SHW-4B for CAA office and SHW-4A when in a hallway or combined with another door)

A - NEW OFFICE BUILDING & NEW OFFICE ANNEX (NOB & NOX)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	Building Safe Haven (Other than or in addition to the PCC)		2133	SHW-4, SHW-4A, or SHW-4B		No glazings are allowed, except a peep hole. SHW set is determined by the secondary use of the space (i.e. specify SHW-4 for a regular office space, SHW-4B for CAA office and SHW-4A when in a hallway or combined with another door)
	MSG access external fire door	Exterior to GWA	2123	SHW-8E or SHW-36B		Should be fire egress door closest to MSGR on compound with direct access to GWA. Also used for internal door separation when MSGR is adjoined or within office building. For exterior blast-rated building location use SHW-36B
	Roof (non-hardline access)		2111	SHW-13A or SHW-38C		For exterior blast-rated building location use SHW-38C
Building System						
IT044	G-02 NOB Telecommunications Service Entrance Facility (NOB TSEF)		2111 or 3111	SHW-13		

A - NEW OFFICE BUILDING & NEW OFFICE ANNEX (NOB & NOX)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
IT026	G-02 Main Terminal Space (MTS)		2111 or 3111	SHW-13		
IT046	G-02Telecommunications Equipment Room (PBX)		2111 or 3111	SHW-13 or SHW-17B Or SHW-17A		When LAA, use SHW-17B or SHW-17A when no SMSe When not LAA us SHW-13.
IT041	G-02 Telecommunications Equipment Room	When Distributed on Each Floor	2111	SHW-14 or SHW-13		SHW-14 assumes C-LAN switches co-located; if not, specify SHW-13
BS087 BS078	F-05 Switchgear, Secondary (Serving the PCC or any forced entry protected power source)		2133	SHW-19B or SHW-33C	Provide sound insulation/ treatment	For exterior blast-rated building location use SHW-33C
BS091	F-05 Generator (PCC)		2133	SHW-19, SHW19B, SHW-33C, or SHW-35C	Provide sound insulation/ treatment	Use SHW-19 for door pairs and SHW-19B for single door applications. For exterior blast-rated building location use SHW-33C and SHW-35C
BS068	H-38- Generator (Protected, Non-PCC)		2123 or 2133	SHW-19A or SHW-35D	Provide sound insulation/ Treatment when located within/close to an office building	For 15 minute FE/BR applications specify DOS Code 2123 and for 60 minute FE/BR (safe haven) applications specify DOS Code 2133. For exterior blast-rated building location use SHW-35D

A - NEW OFFICE BUILDING & NEW OFFICE ANNEX (NOB & NOX)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	Electrical Rooms	Office Building	2111	SHW-13 or SHW-16B		Specify SHW-16B for double doors
BS054 BS055 BS056	Mechanical Rooms	Office Building	2111	SHW-13 or SHW-16B		Specify SHW-16B for double doors
	Fire Command Center	Office Building	2111	SHW-7		Control from Post 1
	RMS, Cooling Towers or any other roof mounted structure with a door	Roof	2111	SHW-13		

B - PEDESTRIAN/CONSULAR CAC (PEDESTRIANS ONLY)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
SC005	E-14 Security Screening	Street Side Entry	1123	SHW-5A or SHW-5C		Use 5A when accessibility is required
SC005	E-14 Security Screening	Exit to street	1123	SHW-5B or SHW-5D		Use 5B when accessibility is required
SC005	E-14 Security Screening	Exit to Compound	1123	SHW-12J or SHW-12I		Use 12J when accessibility is required
SC005	E-14 Security Screening	Compound side entry	1123	SHW-12J or SHW-12I		Use 12J when accessibility is required
SV037	K-12 Consular Pass back Booth		1123	SHW-2C	Remove magnetic lock	
BS121	E-14 Electrical Room(s)		2111	SHW-13 or SHW-16B		Use SHW-16B for a pair of doors
IT018	E-14 or G-02 EC Room (TSS)		2123, 2111 or 3111	SHW-3, SHW-13 or SHW-17		New CACs, use SHW-3. Use SHW-17 when 24/7 AC is NOT provided
RR023	Local Police Bathroom	Access from street	2111	SHW-15A		

C - MAIN ENTRANCE CAC (VEHICLE/PEDESTRIAN)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
SC004	E-14 Security Screening	Street side entry	1123	SHW-5A		
SC004	E-14 security Screening	Exit to Street	1123	SHW-5B		
SC003	E-14 Guard Booth		1123	SHW-3		
SC004	E-14 Security Screening	Sally Port	1123	SHW-12K		
SC004	E-14 Security Screening	Exit to Compound/Compound Entry	1123	SHW-12I or SHW 12J		Use 12J when accessibility is required
VE006	Sally Port – ManTrap Vehicle Gates	Compound and Street				Use Padlocks -- Medeco 54-510R00KA. Exterior grade.
VE006	Sally Port	Compound	--	SHW-22 or SHW-22A		Control in CAC Guard Booth with override controls at MSG Post 1
BS120	E-14 Mech. and Elec. Hydraulic Room(s)	Compound	2123, 2111	SHW-3, SHW-19A SHW-13 or SHW-16		New CACs barrier control room, use SHW-3 or SHW-19A. Specify SHW-16B for door pair
IT018	E-14 or G-02 EC Room (TSS)		2123, 2111 or 3111	SHW-3, SHW-13 or SHW-17		New CACs, use SHW-3. Use SHW-17 when 24/7 AC is NOT provided

C - MAIN ENTRANCE CAC (VEHICLE/PEDESTRIAN)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
CO042	CAC Pre-Screening Room	Access to compound	2123	SHW-2E		
CO042	CAC Pre-Screening Room	Access from the screening area	2111	Privacy Set		See 087135, HW Hardware

D - SERVICE ENTRANCE CAC (VEHICULAR/PEDESTRIAN)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
SC006	E-14 Security Screening	Street Side Entry	1123	SHW-5A or SHW-5C		SHW-5A is recommended. Use 5A when accessibility is required
SC006	E-14 Security Screening area	Exit to Street	1123	SHW-5B or SHW-5D		Use 5B when accessibility is required
SC003	E-14 Guard Booth		1123	SHW-3		
SC006	E-14 Security Screening	Sally Port	1123	SHW-12K		
VE006	Sally Port – ManTrap Vehicle Gates	Compound and Street				Use Padlocks -- Medeco 54-510R00KA. Exterior grade.
VE006	Sally Port	Compound	---	SHW-22 or SHW-22A	---	Control in CAC Guard Booth with override controls at MSG Post 1 Sallyport Gate typically not provided. Provide only with direction of COR and OBO/SM
SC006	E-14 Security Screening	Exit to Compound/ Compound Entry	1123	SHW-12I or SHW 12J		Use 12J when accessibility is required
BS120	E-14 Mech. And Elec. Hydraulic Room	Compound	2111	SHW-19A, SHW-3, SHW-16B		New CACs barrier control room, use SHW-3 or SHW-19A.

D - SERVICE ENTRANCE CAC (VEHICULAR/PEDESTRIAN) SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
IT018	E-14 or G-02 EC Room (TSS)		2123, 2111 or 3111	SHW-3, SHW-13 or SHW-17		New CACs, use SHW-3. Use SHW-17 when 24/7 AC is NOT provided
BS119 WR090	E-14 Transfer Portion: Truck or Trash Transfer	Street Side Loading Dock	2121	--	---	Overhead door. Use two (2) Padlocks -- Medeco 54-510R00KA. Exterior grade. Trash Transfer may use a anti-climb gate.
BS119 WR090	E-14 Transfer Portion: Truck or Trash Transfer	Compound Loading Dock		--	---	Overhead door. Use two (2) Padlocks -- Medeco 54-510R00KA. Exterior. Trash Transfer may use a anti-climb gate.
BS119 WR090	E-14 Transfer Portion: Truck or Trash Transfer	Compound Pedestrian Entry	2111	SHW-13A		Compound side –Exterior of building to compound.
MH005	E-14 Initial Screening (Mail)	Entry	1111	SHW-13		This facility may also be located as a standalone booth.
IT075 BS123 BS124	H-38 Compound Demarcation Room: Electrical Room, Water, Telecom Etc.	Public/ Street	2141	SHW-3B, SHW-19A, or per local regulation		Specify SHW-19A for door pairs. NOTE: There shall not be a door from the exterior of the compound and door from on compound to the same room.

D - SERVICE ENTRANCE CAC (VEHICULAR/PEDESTRIAN)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
IT075 BS123 BS124	H-38 Compound Demarcation Room: Electrical Room, Water, Telecom, etc.	Compound	2111	SHW-13, SHW-16B, or per local regulation		Specify SHW-16B for door pairs NOTE: There shall not be a door from the exterior of the compound and door from on compound to the same room.

E - MARINE SECURITY GUARD RESIDENCES (MSGR)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
CR002	E-18 Foyer/Lobby	Public Entrance	1123 or 1111	SHW-32E, SHW-25 or SHW-26		Use SHW-25 for on compound MSQG DOS Code xx23. For exterior blast-rated building location use SHW-32E.
DD025, F1002, EX011	E-18 Patio, Exercise room and Ground Floor Rooms	*Exterior Entry/Exit Doors	1123 or 2123 or 1111 or 2111or 3111	SHW-33E SHW-25A or SHW-15B		Use SHW-25A for on compound MSQG DOS Code xx23 *Any doors that are also accessible from a DOS ant-climb standard, must also be specified with the SHW-25A or SHW-15B (FY06 and FY07 only) hardware accordingly. For exterior blast-rated building location use SHW-33E
BS096	Mechanical Room	Exterior	2123	SHW-19A or SHW-35B		When access is directly from the exterior. For exterior blast-rated building location use SHW-35B
WR089	Emergency Residential Response Room	Interior	2111	SHW-14A		
	Bedroom Corridor Access	Between representatio	2111	HW		Provide Pushbutton access control

E - MARINE SECURITY GUARD RESIDENCES (MSGR)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP-M Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
		nal part of residence and private sleeping areas				
IT067 IT077	Telephone Room	Interior	2111	SHW-17B, SHW-17A or SHW13		When LAA, use SHW-17B or SHW-17A when no SMSe When not LAA us SHW-13.
IT051	Sub-EC	Interior	2111	SHW-17, SHW-17A, SHW-17B		When LAA, use SHW-17B or SHW-17A when no SMSe When not LAA us SHW-17.
	Roof		2123	SHW-38C		For exterior blast-rated building location use SHW-38C

F - CHIEF OF MISSION (CMR)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
CR005 CR0026	Foyer/Lobby	Public Entrance	1123 or 2123 or 1111	SHW-25A SHW-33E or HW-		Use SHW-25A or SHW-33E for on compound DOS xx23
EX011	Patio and Ground Floor Rooms	*Exterior Entry/Exit Doors	1123 or 2123 or 1111 or 2111or 3111	SHW-25A, SHW-33E or SHW-15B		Use SHW-25A or SHW-33E for on compound DOS xx23 *Any doors that are also accessible from a DOS anti-climb standard, must also be specified with the SHW-25A or SHW-15B hardware accordingly.

G - OUT-BUILDINGS (UTL, SPX, REC, etc.)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

Rm. No. (A/E to Assign)	Plan or SRP Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	UTL: Generator (Protected)	Exterior	2123 or 2133	SHW-19A		Use when generator and transfer switch serve a safe area or safe haven.
	UTL: Generator (Post unprotected)	Exterior	2111	SHW-13 or SHW-16B		Use for post generators and switchgear that do not serve save area or safe haven
	Telephone Room (TR)	Interior	2111	SHW-17B SHW-17A or SHW-13		When LAA, use SHW-17B or SHW-17A when no SMSe When not LAA us SHW-13.
	Sub-EC	Interior	2111	SHW-17 SHW-17B SHW-17A		When LAA, use SHW-17B or SHW-17A when no SMSe When not LAA us SHW-17.
	LGF Training Room		2123	SHW-3A		LGF training/ Briefing/ Break room often are combined. This space in an outbuilding may function as CES.
	Compound Emergency Sanctuary (CES)		2123	SHW-4C		
	Gym (when not in office building)	Entry Exterior	1123	SHW-1C or SHW-32A		For exterior blast-rated building location use SHW-32A

H - Consular Agency (Off-compound)
SECURITY DOOR HARDWARE SCHEDULE PARAMETERS

SRP-M Reference Tag	Plan or SRP Room Description	Location	DOS Code	Security Hardware	Modifications	Comments
	Foyer/Lobby – Consular Agency	Public Entrance	1141 or 2141	SHW-5A		Mag lock may be deleted; Cypto keypad CC-8521B and External FELs added.
	Consular Agency – Staff Entrance	Staff- GWA	1141 or 2141	SHW-18A or SHW-18B		

SECTION 088855 - SECURITY GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies laminated security glazing comprised of both glass and glazing-plastic sheets, combined at fabrication plant, including laminated panels and/or insulating panels for glazing, and including proprietary panels of special fabrication.

B. Related Sections include the following:

1. Division 01 Section "Secure Shipment."
2. Section 080001 “Blast Requirements.”
3. Section 083454 "Forced Entry (FE) / Ballistic Resistant (BR) Door Assemblies."
4. **[Section 084414 “Structurally-Framed Security Curtain Wall System.”]**
5. Section 085651 "Aluminum Security Windows."
6. Section 085652 "Aluminum Security Teller Windows.”
7. **[Other Division 08 Section(s) on glazing and which specify glass support framing for these panels.]**
8. **[Division 01 Section on Building Enclosure (FE/BR Windows and Doors) Commissioning.]**
9. **[Division 08 Section “GPE Window and Door Requirements.”]**

1.2 REGULATIONS AND STANDARDS

A. Standards and codes referenced in this Specification shall be those editions referenced in the applicable version of the OBO Building Codes (OBO adopted codes and OBO Code Supplements) and references cited in those Codes, or those current at the date of this Specification, unless otherwise noted.

B. In the event of a conflict between referenced codes and standards and/or the Drawings and Specifications, the code or standard having the more stringent requirements shall govern.

C. Comply with the following industry Standards, unless more stringent requirements are indicated or are required by an approved product manufacturer:

1. American Society for Testing and Materials (ASTM): Documents specified herein.
2. Glass Association of North America (GANA): “Glazing Manual,” “Laminated Glazing Reference Manual,” and “Tempering Division Engineering Standards Manual.”
3. Insulating Glass Manufacturers Association (IGMA): TM-3000 and TM-4000.

1.3 SUBMITTALS

A. Product data for each type of product and fabricated panels specified, including component element documentation, layup description, and glazing/maintenance/cleaning instructions.

B. Standard test reports including certified test reports confirming compliances. Submit laboratory test reports, showing compliance with performances required for air infiltration and water penetration.

C. Design Data including supporting calculations/analysis/interpolation of performances.

D. Certificates attesting that system will meet specified requirements; provide for each window type.

E. Initial samples: provide four 300 mm (12 inches) square panel samples for each glass type required for Project, complete with required elements included as indicated.

1. For insulating glass panels provide assemblies representative of panels to be used in the finished work, including scheduled glass, coatings, spacers, edge seals, and edge deletion.

F. Manufacturer's Quality Control Program: Submit prior to start of fabrication, including all aspects of manufacturing the glazing.

G. Manufacturer's and Fabricator's Calculations:

1. Submit glass manufacturer's calculations for wind pressure and thermal stress showing the glazing demonstrates compliance with specified requirements. Submit written confirmation that the glass fabricator/manufacturer has reviewed the pertinent shop drawings and has confirmed the acceptability of the proposed use of the specified glass products.

H. Certificates for FE/BR Products: See related forms in other Division 08 Sections.

I. Warranties: Samples of special warranties.

J. Submit samples and manufacturer's performance data, as well as application and removal procedures, for all protection materials.

K. Closeout Submittals:

1. Maintenance Manual: At the completion of the project, digitally submit a maintenance manual for all security glazing components. The FE/BR fabricator may include this information in their FE/BR maintenance manual, in lieu of a standalone document. Include the following information:

a. Instructions for cleaning.
b. Warranties.
c. Manufacturer's product data.

2. Contact information for manufacturers and suppliers of all components used in the glazing makeup.

3. When polycarbonate is used in glazing layup, provide documentation from laminator:

   a. Source of polycarbonate (supplier and location)
   b. Lot number(s) of polycarbonate used for each project.

1.4 QUALITY CONTROL

A. Environmental Performance Qualifications:

1. The Manufacturer shall use fabrication techniques to construct certified laminated glazing in such a manner that they have constructed system which has survived, without damage, each of the following environments for at least 72 hours:

   a. High temperature and high humidity, 60 deg C (140 deg F) and 95 percent relative humidity.
   b. Low temperature and low humidity, -18 deg C (0 deg F) and 10 percent relative humidity.

B. Comply with recommendations of GANA Glazing Manual and Sealant Manual, except where more stringent requirements are indicated.

C. Manufacturer's Quality Control Program:

1. Prepare and implement a comprehensive written Quality Control Program covering all phases of the glazing work including, but not necessarily limited to, the following:

   a. Procurement of materials, including quality assurance programs of major suppliers.
   b. Clean room requirements.
   c. Fabrication of components.
   d. Production testing.
   e. Final assembly of components.
   f. Cleaning protocols of components and final glazing panels.
   g. Installation and site quality control.

2. Quality Control Program shall indicate the following for each quality control measure/activity:

   a. Item/property being inspected/tested
   b. Control point in process and frequency of inspection/testing
   c. Inspection/test method
   d. Acceptance criteria and reference standards/specifications
   e. Method of documentation
   f. Action to address deficiencies

3. Quality Control Program shall include detailed descriptions of inspection and production testing programs and inspection reports for:

   a. Glazing fabrication

b. Structural glazing.

4. At the request of the Project Director/COR, a Government representative shall be allowed access to the Contractor's facilities and those of major suppliers, with advance notice, to monitor QC procedures. Make available all QC Program records upon request.

D. Quality Inspections

1. Inspect each glazing layer for Optical defects thoroughly for observable edge damage, face imperfections, optical defects, or distortion prior to assembly in accordance with the ASTM standards below:

a. ASTM C 1036 for flat glass.
b. ASTM C 1048 for heat strengthened glass.
c. ASTM C 1172 for laminated glass.
d. ASTM C 1349 for flat glass clad polycarbonate.
e. ASTM C 1376 for pyrolytic and vacuum deposition coatings on glass.

2. Ballistic Resistant glazing layup with spall liner: Damage to spall liner or shatter resistant window film is considered a compromise to SD-STD-01.01 certification performance.
3. Conduct routine in-house staff training to ensure awareness of factors that affect polycarbonate cracking, including environmental stress cracking, creep, and non-compatible materials.

E. Quality Control inspection documents shall incorporate:

1. Detailed description of glazing layup.
2. Acceptance criteria, optical defect limitation tables, industry terminology for defects, means of detection, and other requirements of referenced standards, applied to entire layup.

1.5 IDENTIFYING DEVICES

A. Provide fritted or etched label within glazing panel layers with the following information: manufacturer's name, date of manufacture, DOS Code number, and Glazing Layup number, and glazing panel dimensions in mm. Locate label in lower right corner on the protected side and visible after glazing is framed and cladded.

B. Provide "ATTACK SIDE" removable label on attack side of glazing panel in very conspicuous location.

C. Glazing panels that include the CAA metallic coating described in Part 2 Article on MISCELLANEOUS GLAZING MATERIALS shall be identified by 10 mm (3/8-inch) diameter black dot located on lower right-hand corner of glazing panel viewed from the protected side of glazing panel, and identification shall be embedded within glazing layup.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect laminated security glazing panels against face and edge damage during entire sequence of fabrication, handling, and delivery to installation location. Provide protective covering on exposed faces of glazing plastics, and mark inside as "INTERIOR FACE" or "PROTECTED FACE."

1. Treat security glazing as fragile merchandise, and packaged and shipped in cases or racks, not comprised of wood manufactured with phenols, and blocked together in a mass. Do not use plastic or polyethylene sheeting, or extruded polystyrene. Storage and handling shall comply with Manufacturer's directions and as required to prevent edge damage or other damage to glazing resulting from effects of moisture, condensation, temperature changes, direct exposure to sun, other environmental conditions, ground contaminants, and contact with chemical solvents.
2. Protect sealed-air-gap insulating glazing panels from exposure to abnormal pressure changes, as could result from substantial changes in altitude during delivery by air freight. When windows will be installed in a location that has a different above sea level elevations than where they were manufactured and as a result will cause the glass to deflect, provide temporary capillary/breather tubes which do not nullify applicable warranties on hermetic seals.
3. Temporary protections: Security glazing shall be temporarily protected with manufacturer-applied compatible, peelable, heat-resistant film. This film shall be peeled by Contractor for inspections, and re-applied by Contractor, in accordance with manufacturer’s recommended procedures.
4. Conduct thorough visual inspections of the glazing prior to packaging.
5. Pack replacement glazing panels with no more than two panels per crate. Provide replacement glazing tape, setting blocks, spacers, and other required accessories, packed in the same crate as the glazing panels.
6. Include warning label(s) that clearly indicates non-compatible materials for temporary protection during construction and cleaning. Include this information on the manufacturer’s product literature, warranties, and other documents provided to the construction team and building occupants.
7. Store materials in a dry, well-ventilated location. Keep handling of materials to a minimum, and carefully protect materials from soiling and from condensation and other harmful moisture. Provide vapor-permeable materials for protection during shipping. Do not trap moisture within or adjacent to windows.
8. Conduct thorough visual inspections of glazing before installation. Inspections should include removal of glazing stops, if applicable. Do not install glazing with cracks in the polycarbonate.

1.7 SPECIAL PRODUCT WARRANTIES

A. General: Comply with Division 01 Section “Closeout Procedures” for furnishing to Government of specific warranty on each required type of laminated security glazing, executed by authorized officer of manufacturing/fabricating firm, and agreeing to replace defective panels during the warranty period following panel installations at Project Site. Government will certify that it will continue proper maintenance and non-exposure to destructive forces exceeding those forces

indicated to be satisfactorily resisted by panels without incurring permanent damages. Defective panels are defined to include delamination, change of optical characteristics, glass/plastic breakage or cracking, weathering, change of light/heat/solar transmittances, abnormal aging, and, for insulating panels, loss of hermetic seal.

1. Warranty Period: 5 years for delamination; 10 years for all other defects from Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Responsibilities for ensuring conformance to performance requirements of this Section shall be handled by engineer with Delegated Design responsibilities for associated glazed assembly; see applicable Division 08 Section(s).

B. Blast Resistance: See Section 080001 “Blast Requirements.”

C. Forced Entry and/or Ballistic Resistance: Provide product which has been certified by Bureau of Diplomatic Security (DS) in accordance with DS/PSD Standard SD-STD-01.01, Revision H, for requirements related directly to the glazing.

D. Performance Parameters for Glazing with CAA Metallic Coatings: Glazing with CAA metallic coatings identified in the Part 2 Article on MISCELLANEOUS GLAZING MATERIALS have non-security performance limitations related to the varying characteristics of each approved product. Examples of these characteristics include solar heat gain coefficient (SHGC) and visible light transmittance (VLT). The performance characteristics of these products shall be factored into the overall performance for glazed units using this coating.

E. Each glazing shall withstand normal temperature changes, wind loading, in accordance with ASTM E 1300, usual material handling, and impact loading without breakage.

F. Provide glass of the appropriate thickness and strength to withstand anticipated thermal stresses based on a probability of breakage not to exceed 8 lites per 1000 for vertical glazing.

G. Windborne-Debris Impact Resistance: Provide resistance to windborne-debris impacts as indicated in other Division 08 Sections.

H. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

I. Distortion: Per ASTM C 1036-16, paragraph 6.1.2; applicable to complete glazing panel, vision interference angle greater than or equal to 15 degrees, as observed by an unbiased observer (one who has not viewed up-close or been informed about the panel beforehand), viewed at eye level for a maximum duration of two minutes.

J. Air Gap: Provide adequately sized air gap to prevent lites from touching when deflecting as a result of exterior and interior environmental conditions.

2.2 GLASS CLAD POLYCARBONATE SYSTEM

A. Glazing fabricated with chemically or thermally strengthened or annealed glass panes and polycarbonate sheets, each pane or sheet interlayered with polyvinyl butyral interlayers (PVB) or thermoplastic urethane (TPU) as appropriate, combined for permanent, stable bond. For glass-to-glass use PVB, and for glass-to-polycarbonate use TPU. Provide spall liner at interior (protected side) exposed polycarbonate surfaces (see paragraph on Spall Liner in the Part 2 Article on GLAZING PANEL PRODUCTS, GENERAL, and paragraph on Exposed Glazing Surfaces (general requirements) in the Part 3 Article on GLAZING PANEL FABRICATION) for additional requirements).

2.3 GLASS, AIR GAP, AND POLYCARBONATE SYSTEM

A. Glazing fabricated using alternate layers of chemically strengthened, heat strengthened and tempered or annealed glass laminated with polyvinyl butyral (PVB) interlayers. The polycarbonates shall be fusion bonded without interlayers into a solid core, or shall be laminated with thermoplastic urethane (TPU) interlayers. The glass layup shall be separated from polycarbonate layup by means of air gap. Provide spall liner at interior (protected side) exposed polycarbonate surfaces (see paragraph on Spall Liner in the Part 2 Article on GLAZING PANEL PRODUCTS, GENERAL, and paragraph on Exposed Glazing Surfaces (general requirements) in the Part 3 Article on GLAZING PANEL FABRICATION) for additional requirements).

2.4 GLASS, AIR GAP, AND IONOMER SYSTEM

A. Glazing fabricated using chemically or thermally strengthened or annealed glass laminated with ionomer interlayers. The glass layups shall be separated by means of air gap.

2.5 GLAZING-PANEL PRODUCTS, GENERAL

A. Heat-Treated/Strengthened Glass: Provide float glass complying with ASTM C 1036, Type I, Quality q3, of the following Class, which has been heat treated in accordance with ASTM C 1048, Condition A (uncoated), Kind FT (fully tempered) except as otherwise indicated.

B. Roller distortion for each individual piece of glass: Measured peak to valley, shall not exceed 0.0762 mm (0.003 inches) in the central area or 0.2032 mm (0.008 inches) within 266.7 mm (10.5 inches) of the leading or trailing edge.

C. Chemically-Strengthened Glass: Manufacturer's/Fabricator's proprietary system of chemical bath treatment in which sodium ions in glass faces are replaced with larger ions, resulting in a permanent degree of temper which amounts to a modulus of rupture (MOR) increase to at least 30,000 psi for thicknesses of 3 mm (1/8 inch) and less, per ASTM C 158.

D. Annealed Glass: Except as otherwise indicated, provide float glass; ASTM C 1036, Type I, Quality q3, of indicated Classes (tints) and thicknesses.

E. Glass Colors (Tints): Provide glass in following colors or tints, as indicated, per ASTM C 1036; provide Class 1 "clear" where there is no indication of color/tint requirement:

1. Class 1, clear.

F. Polycarbonate Glazing Plastic: Provide polycarbonate sheets complying with Commercial Item Description (CID) A-A-59502, with minimum flexural strength of 93.1 MPa (13,500 psi) per ASTM D 790, with 116 C (240 deg. F) allowable continuous service temperature, and with Izod impact strength of 0.854 N-m/mm (16 ft-lb per inch), per ASTM D 256. Provide in sizes and thickness as indicated in clear colorless transparent sheet, with light transmittance and thickness in accordance with ASTM C 1349-04, Type 1 UV stabilized, Table X1.2, when measured in accordance with ASTM D 1003.

1. Bonded Sheets: Where bonded polycarbonate sheet thickness of more than 9.5 mm (0.375 inches) is indicated, provide fusion-bonded-ply construction to form a solid sheet of thickness indicated in lamination

G. Glass-to-Glass Interlayers:

1. Clear polyvinyl butyral (PVB) laminating film/sheet. Except as otherwise indicated or required to achieve performances, provide 0.76 mm (30-mil) minimum thickness; provide 1.52 mm (60-mil) minimum thickness where one or both glass sheets have been heat strengthened or chemically strengthened. Assure that PVB layer does not contact urethane or polycarbonate as it can adversely affect these materials.
2. Ionmer sheet. Except as otherwise indicated or required to achieve performances, provide 1.52mm (60-mil) minimum thickness.

a. Acceptable products:

1) Noviflex by AGP
2) SentryGlas Xtra by Kuraray

H. Polycarbonate-Contact Interlayers: Laminator's clear proprietary urethane-type laminating film/sheet. Except as otherwise indicated or required to achieve performances, provide 0.635 mm (25-mil) minimum thickness, and provide 1.27 mm (50-mil) minimum thickness where polycarbonate is laminated to heat-strengthened or chemically-strengthened glass.

I. Edge protection: To cushion and protect glazing edges from contamination or foreign matter, the four edges shall be sealed the depth of glazing with continuous standard-thickness TPU or Santoprene tape. Alternatively, continuous channel shaped extrusion of Santoprene shall be used, with flanges extending onto faces of glazing.

J. Shatter Resistant Window Film (as a spall liner): Provide as required for ballistics or blast performance of glazing layup. When required, provide factory installed.

1. SRWF may be field replaced if damaged in accordance with glazing manufacturer instructions. Replace only with approved product consistent with FE/BR testing and/or with blast calculations.

K. Spall Liner: Provide chemical resistant polyethylene (PET) spall liner laminated to interior (protected) side of glazings that utilize a polycarbonate on the interior (protected) most side, with TPU interlayer; or on glass layers as required for forced entry or ballistic performance per certified design.

1. Approved Products [chemical resistant spall liner]:

a. Madico Spall Shield CL-700SRB TPU, CL-700SRB PVB, or LCL1500 SRB TPU.
b. Kuraray Spallshield.

L. Anti-Reflective Coating at Consular Teller Windows: Provide anti-reflective coating on #1 surface (exterior surface) to reduce reflectivity of glass surface, increase light transmission and decrease obscurity when viewing from either side of the transparency. Anti-reflective coated glass substrate shall have less than 8% exterior reflectance. Anti-glare coatings or surface etching are prohibited as they can alter image quality in viewing due to defusing light. Anti-reflective surface applied films are prohibited.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. Silicone Sealants: ASTM C920. Shall withstand 50 percent joint width change when tested per ASTM C719.

B. If glazing contains any polycarbonate, all glazing materials shall be approved by manufacturer, including those specified above, and pre-shimmed glazing tapes, cleaners, primers, etc.

C. CAA Metallic Coating: CAA glazings and identified glazings in the drawings and windows schedules shall receive one of the following DOS approved coatings or interlayer products. Refer to Part 2 Article on PERFORMANCE REQUIREMENTS for performance parameter limitations for glazing with these coatings. Refer to Part 1 Article on IDENTIFYING DEVICES related to glazing with these coatings.

1. Solarban 70XL: Two coats of Vitro Solarban 70XL coating applied under the first layer of glazing, Coatings shall be applied to subsequent layers of glass, the first coating shall be applied to inner face of a layer of glass, the second to the outer layer of the subsequent layer of glass.
2. Viracon VE1-2M Cybershield Glazing: One coat of VE1-2M coating applied to the number two surface (inner face of first layer of glass which will serve as exterior of layup) Viracon Datastop Coating on the number 4 and 6 surfaces (after the first glazing facing the air space and on the following glazing panel). Provide conductive gasketing between datastop coating and window frame.
3. Viracon VRE1-59 Cybershield Glazing: One coat of Viracon VRE1-59 coating applied to the number two surface (inner face of first layer of glass which will serve as exterior of layup) with Viracon Datastop Coating on the number 4 and 6 surfaces (after the first

glazing facing the air space and on the following glazing panel). Provide conductive gasketing between datastop coating and window frame.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. The installation of glass-and-plastic glazing panels is specified in other sections of these specifications; not work of this Section.

B. Replace panels containing imperfections, distortion, or damage.

3.2 GLAZING-PANEL FABRICATION

A. Industry standards: Comply with applicable requirements by GANA standards titled "Glazing Manual" and "Sealant Manual."

B. Use no materials, equipment or practices that may adversely affect the function, appearance, performance, or long-term durability of the completed glazing assembly or adjacent construction.

C. When possible, reduce exposure to non-compatible chemical substances including, but not limited to, the following:

1. Phenols
2. Silicone-based sealants (non-neutral cure agents)
3. Cutting oils
4. Common cleaning chemicals known to contribute to polycarbonate environmental stress cracking such as ammonia.

    a. Isopropyl not allowed, unless rinsed with water.

5. Ethylene-propylene rubber (EPDM) setting block off-gassing compounds.

D. Manufacturer Requirements:

1. Fabricate laminated assemblies utilizing automated or computer feedback-controlled autoclave processes that monitors temperatures and pressures during autoclaving to confirm the rate of heating and cooling using thermocouples.

    a. Recommended Best Practice: Air gap between laminated layups within autoclaving equipment and horizontal orientation with ample space for airflow between laminated layups provides best results.

E. Manufacturer's Standards:

1. Materials, components, and systems incorporated in the Work shall be mixed, applied, installed and otherwise used in strict accordance with the recommended standards and procedures of the respective manufacturers.

F. Laminated Glass-and-Plastic Panels: Laminate panels by manufacturer's standard heat-plus-pressure process to produce laminations free from foreign substances, including air pockets.

G. Insulating Glass-and-Plastic Panels: Fabricate panel by manufacturer's standard process to produce and maintain dry-and-clean air/gas space between glass exterior and plastic interior sheets using flexible proprietary hermetic edge sealer/spacer bar materials and special corner construction. At Fabricator's option, where insulating glazing panels are indicated for interior partition installations, and both faces are exposed to relatively constant-temperature indoor environmental conditions, provide Fabricator's standard metal-tube-type hermetic edge sealer/spacer-bar materials for non-flexible performance between sheets not subject to significant thermal expansion differential.

H. Exposed Glazing Surfaces:

1. General: Provide edge-banding on panels with exposed edges of polycarbonate.
2. Window and Door Glazings: Glass is required on all exterior surfaces. Interior surface (protected side) may use glass or polycarbonate with adhered chemical resistant PET-(PolyEthylene Terephthalate coating) spall liner.

I. Tolerances:

1. Thickness: Unless otherwise specified, glazing industry thickness tolerances are acceptable for all components used in laminated security glazing assemblies.
2. Outside dimensions: Overall outside dimensions (height and width) of laminated security glazing shall maintain tolerance of +/- 3 mm.
3. Maximum Allowable Overall Bow: ASTM C 1349 Table 1.
4. Mismatch of Laminated Glazing: 1mm maximum between any two plies of the glazing panel on the sill side and 4 mm maximum between any two plies on all other sides. Provide temporary label identifying sill side.

3.3 PROTECTION AND CLEANING

A. Refer to Division 08 Sections associated with these security glazings for additional protection and cleaning requirements.

B. Clean polycarbonate surfaces that have been exposed to known environmental stress cracking agents during fabrication. Use cleaning practices recommended for polycarbonate. Provide documentation logs of all panels exposed to such agents.

C. Protect the glazing from any material, equipment or practices that may impair the functioning, appearance, or durability of the glazing or other construction.

D. Package and store materials in a manner that shall prevent damage, contamination, distortion, breakage, or structural weakening.

E. Replace any material damaged during manufacture, shipping, storage, or erection.

1. Ballistic Resistant glazing layup with spall liner over glass on protected face (i.e., DOS 1123):

a. Visual defects of the spall liner such as scuffs or distortion, are not permitted.
b. Perforations through the spall liner are considered non-compliant and will compromise SD-STD-01.01 certification performance and must be replaced.
c. Temporary mitigation of damaged spall liner is not permitted unless specifically approved in writing by OBO/SM/SEB. Temporary mitigation will only be considered when replacement glazing is ordered and time does not permit replacement prior to accreditation; however, replacement is still required.

2. Ballistic Resistant glazing using Shatter Resistant Window Film (SRWF) (i.e., DOS 1123):

a. Visual defects of the spall liner such as scuffs or distortion are not permitted.
b. Perforations through the SRWF are considered non-compliant and will compromise SD-STD-01.01 certification performance and must be replaced. With approval of window manufacturer of material and installation requirements, SRWF may be field replaced.

F. Protection materials, such as plastic membrane tapes and adhesive sheeting, shall be suitable for the intended protection application and protection period.

1. Provide labels (on crate and on the film) indicating the date of protective membrane installation and the date when it should be removed.
2. If the film is removed, provide instructions for interim protection until the window is installed.

G. Install protection materials in a manner that will not trap harmful moisture or otherwise contaminate the Work in any way.

H. Acceptance of the completed installation of the glazing requires the installation be sound, watertight, and free from defects of materials and workmanship.

3.4 SECURITY GLAZING SCHEDULE

A. [Glazing Type GL-01 (Vision Glass):

1. Insulating glass panel consisting of:

a. Outer lite: Laminated glass with Xxx Xxx coating on the surface facing the air gap.
b. Air Gap: XX mm (XX inch) minimum air gap with black spacer.

c. Inner lite: Glass-clad polycarbonate faced with a 0.XX mm (0.0XX-inch) thick, spall-resistant xxx film laminated to indoor face and with xxx xxx coating applied to the surface facing the air gap.

2. Performance characteristics shall be equal to or better than the following:

a. Visible Light Transmittance (VLT): XX percent min.
b. Reflectance (vis,out): XX percent max.
c. U-value (summer): 0.XX max.
d. Solar Heat Gain Coefficient (SHGC): 0.XX max.]

END OF SECTION 088855

SECTION 089117 - SECURITY LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of security louvers required to provide specified resistances is indicated on Contract Drawings.

B. Install security louver assemblies only into a steel substrate in such a manner that allows for future adjustment. This may be either a structural steel wall or other structural steel assembly, a tube steel sub-frame or steel embed in concrete, or a tube steel sub-frame attached to concrete or masonry.

C. Related Sections include the following:

1. Division 01 Section "Secure Shipment."
2. Section 033000 “Cast-in-Place Concrete” for concrete substrates which provide anchorage/support for work of this Section.
3. Division 055005 “Metal Fabrications” for structural steel framing work, fabrication, and metal treatments/coating for supporting louvers of this Section, and for basic metal fabrication requirements.
4. Section 099602 “High-Performance FE/BR Coatings.”

1.2 PRE-INSTALLATION MEETINGS

A. Before beginning installation of the FE/BR assemblies, the manufacturer's technical representative shall conduct a pre-installation conference at the Project site with the Installer, the Project Director/COR, and other interested parties to review installation procedures and manuals, schedules, and coordination of the FE/BR-assembly installation with other elements of the Work.

1.3 ACTION SUBMITTALS

A. General:

1. All submissions must be in accordance with Division 01 Specifications.
2. Submit shop drawings, samples, data, reports, and engineering calculations for the Project Director/COR 's approval before proceeding with the Work of this Section. Upon award of contract, provide a submittal log and a list of major products proposed to be furnished. Submissions shall be made according to a schedule that allows adequate time for review and approval by the Project Director/COR as stated in Division 01 and the General Conditions.
3. Submissions shall be complete and comprehensive and include all shop drawings, samples, material data submissions, and engineering calculations for the part of the assembly addressed. All work shall be coordinated by the Contractor prior to submission.

Incomplete, non-conforming, or uncoordinated submissions are subject to rejection or return without action by the Project Director/COR. Any work executed which deviates from approved shop drawings and submittals are subject to rejection.

B. Product data for each manufactured component, accessory, material, and device required for fabrication of louver units, including hardware, installation inserts, anchors, and similar elements.

C. Manufacturer's Certifications:

1. Provide a copy of the Letter from manufacturer indicating the products have been certified by Bureau of Diplomatic Security (DS) in accordance with the Part 2 Article on PERFORMANCE REQUIREMENTS.

D. Standard test reports including certified test reports confirming compliances. Submit laboratory test reports demonstrating conformance with required air flow capability identified in the Part 2 Article on PERFORMANCE REQUIREMENTS.

E. Engineering Calculations:

1. Submit project-specific engineering calculations as described herein and in the General Conditions and to address the performance requirements in this specification section for the louver system and its attachment to the supporting building structure.
2. Submit engineering calculations concurrently with corresponding shop drawings to include free area calculations and other calculations required to support the design. Include calculations of air pressure drop, airflow, and similar applicable mechanical design performance.
3. Calculations shall bear the seal and signature of a Professional Engineer licensed in accordance with Chapter 1 of the OBO Building Code.
4. For data including engineering design showing compliance with physical performance requirements.

F. Shop drawings showing dimensioned details of louvers, including performance rating and adjacent construction. After final modifications and corrections have been incorporated, submit drawings as AutoCAD files with .DWG extension. Show the following:

1. Cover sheet: Include manufacturer's name, address, telephone, and facsimile numbers; customer and address; project location; contract or purchase order number; and submittal release record.
2. Unit information:

   a. Mark (louver no.).
   b. Manufacturer's model number.
   c. Government DOS model number.
   d. DOS code.
   e. Louver/frame finish.
   f. Louver type (interior or exterior).

3. Elevation Drawings: Show typical louver exterior elevations at not less than 1:20 scale.

a. Rough opening dimensions.
b. Frame opening dimensions.
c. Separate steel sub-frames (number and list).
d. Detail symbols.
e. Mark (louver number)

4. Plan Drawings:

a. Relate to elevation on drawing.
b. Identify "Attack" and "Protected" sides.
c. Mark (louver number)
d. Indicate room space numbers taken from Contract Drawings.
e. Orientation of the louver (i.e., either vertical or horizontal as in a slab).
f. If applicable, include Manufacturer's name and reference numbers for primer and finish paint, including number of coats applied; see Section 099602 "High-Performance Coatings."

5. Details: Show section at 1:5 scale of members indicating construction, size, and thickness of components, louver blade profiles, anchorage, steel sub-frames, continuous shim plates (where applicable), and spacing details, together with connections, fastenings, shims, sealant, backer rods, and means of separating dissimilar metals. Details shall be on separate sheets from plan and elevation drawings. Include sections that show the jambs, head, and sill condition to include drainage systems (e.g., weep holes, drainage channels), and weather proofing and flashing that has been coordinated with the weather proofing systems.
6. General Product Information: Include notes sheet, miscellaneous materials specifications, abbreviations, finish/paint system, and legend.
7. Breakdown of Product Line Items:

a. If Manufacturer produces one contract line item as several parts, they shall break out items on drawings. Each item shall be a subdivision of that product line item number.

8. Engineering Calculation Summaries: Include summary of key engineering design calculations to confirm compliance with the Part 2 Article on "Performance Requirements."
9. Certificates of compliance confirming adequacy of performance for required units.

a. Where air flow requirement is identified, certify compliance with the Performance Requirements of this Section.
b. Provide air flow test reports that are both directions across the louver for the as-tested FE/BR size.

10. Submittal shall cite all anchorage components, including complete description of anchors and installation criteria such as drilling specifications into concrete or masonry, torque requirements, minimum edge distance, spacing, etc.

a. For sub-frame attachment to concrete, Contractor's instructions shall include alert to installers to avoid cutting rebar during concrete anchor installation.

11. Installation instructions shall be customized for each type of application.

G. Manufacturer's Technical Representative and Contractor shall review the design and submit a list of unique project specific site conditions that require special manufacturer representative inspection and/or installation training.

1.4 INFORMATIONAL SUBMITTALS

A. General:

1. Informational submittals shall be submitted at least four weeks prior to installation.
2. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Qualification Data: For Manufacturer and Installer in accordance with the Part 1 Article on QUALITY ASSURANCE.

1.5 CLOSEOUT SUBMITTALS:

A. General:

1. Refer to Division 01 Sections on Submittals and on Closeout for general administrative requirements.

B. Special Warranty: Provide special warranty in accordance with the Part 1 Article on WARRANTY.

C. Maintenance Data.

1. Data shall include instructions for cleaning and maintenance.

D. Inspection Reports and Certificates of Compliance: See forms at end of this Section.

1. Provide Table of contents and/or bookmarks organizing by building and floor for each product using contract identification number.
2. Provide plan showing location of products (one plan may cover multiple products or whole floor if legible).
3. Provide completed certificates of compliance documenting that all FE/BR louver assemblies have been installed in accordance with contract documents including all supplemental photographs, sketches, and drawings. Signed by certified installer.
4. Provide any additional QC documents used by Contractor during the installation. including all supplemental photographs, sketches, and drawings.

1.6 QUALITY ASSURANCE

A. Testing Laboratory Qualifications: For compliance with non-security performance requirements on security louver assemblies of this Section, use only those testing laboratories which have

successfully demonstrated to Project Director/COR that they have experience and capabilities needed to satisfactorily conduct required tests.

B. Quality Control for Forced-Entry/Ballistic-Resistant (FE/BR) Products: Certify compliance of fabricated and assembled FE/BR products specified in this Section with each quality control procedure established by the Government; these procedures are identified in the Compliance Form at end of this Section.

C. Delegated Design Responsibility: Contractor shall retain an experienced Professional Engineer, registered in the U.S. or in country with significant experience with louvers of similar complex performance requirements, and acceptable to the Project Director/COR, to perform responsibilities of Delegated Design.

D. Qualifications: The sub-contractor, including the team lead, shall have a minimum of three years of experience in the installation of FE/BR Louvers. If the team lead will also serve the function of the technical representative, then they should have experience installing the manufacturer's louver that will be installed or factor trained. The team lead shall have the ability to read and understand the Contract Drawings, Specifications, shop drawings, and installation manuals by the manufacturer.

E. Manufacturer's Technical Representative: For new construction and renovation projects with five or more FE/BR louvers or if the project includes more than 20 FE/BR products, regardless of manufacturer, the FE/BR supplier shall appoint a manufacturer's technical representative to the project. The manufacturer's technical representative shall be an employee of the manufacturer. If no technical representative is appointed, the contractor's team leader shall fulfill the training and installation supervision requirements for the manufacturer's representative. The manufacturer's technical representative shall have the following responsibilities:

1. Pre-Installation Conference: See the Part 1 Article on PRE-INSTALLATION MEETINGS.
2. Installation Team Training: The manufacturer's technical representative shall provide the crew which is to perform the installations of the FE/BR assemblies on-site, hands-on training to include the entire assembly of the first FE/BR louver. The manufacturer's technical representative shall also instruct the crew on preventive measures which must be taken to protect the FE/BR assemblies from damage during construction.
3. Inspection: See the Part 3 Article on FIELD QUALITY CONTROL.
4. Additional Assistance: The manufacturer's technical representative shall provide the Contractor any additional advice, instruction, training, supervision, or inspection required to enable the Contractor to complete the installation certification described below, and to fully train the Embassy staff in the proper operation and maintenance of the FE/BR assemblies.

F. Team Lead for FE/BR product installation: Each project shall designate a "Team Lead" for the installation of FE/BR louver products. Team lead shall have the following responsibilities:

1. Shall be familiar with the scope of the project, has reviewed the submittals.
2. Shall be trained in the field by the Manufacture's technical representative or provides appropriate proof of certified installer per ARTICLE on Qualifications

3. Shall be responsible for the installation team and quality of the installation.

   a. Fills out the “Certificate of Compliance” for each Marked unit.
   b. Coordinates with the Contractor Quality Control Manager.

G. Certification by General Contractor: Prior to final completion, the General Contractor shall provide to the Project Director/COR a certification that the FE/BR materials have been installed in accordance with the manufacturer's instructions, these specifications and are operational. Use Certificates of Compliance forms at end of this Section. Deviation from these requirements is only permitted with the written approval of the Project Director/COR with input from the OBO/CFSM/SM Physical Security Engineer. Specifically, the General Contractor's certification shall include verification that:

1. The manufacturer's technical representative or Team Leader (as allowed by the Part 1 Article on QUALITY ASSURANCE) was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing security louvers has received training. See the requirements for the representative or leader in the Part 1 Article on QUALITY ASSURANCE.
2. Each sub-frame has been installed level, plumb and square.
3. All pre-fabricated sub-frame assemblies, to include embeds, have been factory welded together.
4. Employees performing the installation meet the specified training and experience qualifications.
5. All temporary bolts have been replaced with permanent bolts.
6. All frame bolts have been torqued per manufacturer’s specifications. Shims have been inserted at all bolt locations, minimum one shim per bolt.
7. Maximum gap at shim space is no more than 6.5mm (1/4”) or as per the manufacturer’s specifications based on the tested and DS certified assembly. A minimum of one shim at each bolt location has been provided.
8. Frame bolts/screws are per the approved shop drawings. When within a blast envelope of a structure, blast design and anchorage requirements have been met.
9. All product bolts, screws and anchors are metric products.
10. Separate pieces of ballistic trim have been installed, as indicated in the approved shop drawings.
11. Ballistic trim bars have been secured/screwed to the sub-frame and not the louver frame.
12. The manufacturer has provided two metal ID plates for each louver that has machine applied letters and numbers.

H. Employ only experienced tradesmen for fabrication and installation, who are capable of producing work of the highest standard of quality in the industry.

1.7 IDENTIFICATION SYSTEMS

A. Identify each assembly to provide the Government with ready reference to original manufacturer to facilitate reorders, replacement parts, service, resolution of complaints, and inventory. The label shall be typically embossed/printed metal plate or metallic foil with adhesive backing for permanent identification. One label shall be visible after installation from interior and shall be

located at the lower right-hand corner if installed vertically. A second label shall be mounted on a primary, non-removable component of louver. The labels shall be approximately 40 by 75 mm and shall cite:

1. Manufacturer's name/city/state.
2. Contract number.
3. Month/year of manufacture.
4. Mark number.
5. DOS certification model number.
6. DOS digit code (i.e. 2123, 2133, etc).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver each assembly to project site with fabrication, finishing, and assembly of primary panels, sub-frames, and frames completed and prepared for installation and connection with security systems. Refer to Division 01 Section “Secure Shipment” for additional requirements.

B. Pack louver assemblies and accessories in two crates: one crate for the louver, and one crate for the sub-frame and ballistic trim. Provide a separate compartment in each crate for installation hardware. With Project Director/COR approval, for larger projects, embeds and/or subframes, may be shipped separately and may be crated or containerized, provided they are properly braced to prevent bending, twisting or damaged in shipping.

C. Provide protection of pre-finished units.

D. Treat security louver assemblies as fragile merchandise, and package and ship in export wood cases blocked together in a mass. Comply with Manufacturer's directions for storage and handling to prevent edge damage or other damage to assembly resulting from effects of moisture, condensation, temperature changes, direct exposure to sun, and contact with chemical solvents. Clearly mark crates to indicate which side should be opened first.

E. Clearly sub-frames with louver mark number. Identify “sill”; horizontally-installed louvers (e.g, installed within slab) shall be marked with identifier that matches marking on louver (i.e., “side A”) and “attack side.” Package sub-frames separately and ship in export wood crates separate from the louver assemblies. Protect each sub-frame piece to minimize damage to finished surfaces.

F. Package and ship installation hardware (anchors, bolts, screws, shims, ballistic trim, installation manual, etc.) for each louver in the same crate as the louver assembly. With Project Director/COR approval, for larger projects, may be shipped separately and may be crated or containerized, provided they are properly braced to prevent bending, twisting or damaged in shipping.

G. Package and ship shop drawings and installation manual for louvers prior to door assembly **[may be shipped with the louvers]**. When shipped with louvers, crate shall clearly indicate on the outside that it contains the shop drawings and installation instructions and be marked, “open first.”

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace louver that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Deterioration of metals, other materials, and metal finishes beyond normal weathering.

2. Warranty Period:

a. Louvers: Manufacturer will warrant the doors for a period of five years from substantial completion.

3. See Section 099602, “High-Performance FE/BR Coatings” for coatings warranty.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Fabricate and install security louvers to successfully achieve indicated levels of resistance to security attacks. Resistances apply to anchorages, framing, louver blades, fasteners, hardware, and accessories, along with providing minimum ratio of 1:3 for open air-passage way to gross louver face area, achieving long-term resistances to effects of weathering and exposures to deterioration, and resisting (as applicable) penetration of water, light, sight, dirt, birds/animals, insect screen (if required/project specific), and similar intrusions of deleterious nature as applicable for indicated use in each case.

B. DOS Louver Codes: For each performance identified below, provide specific performance ratings, also referred to as Government Code numbers, as indicated in Table 2.1, “Louver Codes.”

1. Forced-Entry (FE) resistant assemblies: Where louver assembly is shown or scheduled as FE, provide assemblies conforming to rating for attack with ordinary hand tools for rating categories established by Physical Security Division of the Bureau of Diplomatic Security (DS/PSP/PSD).
2. Ballistic Resistance (BR) assemblies: Where louver assembly is shown or scheduled as BR, provide assemblies conforming to rating for ballistic attack for rating categories established by Physical Security Division of the Bureau of Diplomatic Security (DS/PSP/PSD).

TABLE 2.1: LOUVER CODES

DOS CODE	1st DIGIT – NOT USED	2nd DIGIT – NOT USED	3rd DIGIT – FORCED ENTRY RATING	4th DIGIT – BALLISTIC RESISTANCE RATING
1	Transparent	None	None	None
2	Opaque	*	15 minutes	Not Used
3	*	*	60 minutes	Rifle 5.56 & 7.62 NATO
4	*	*	5 minutes	Armor-Piercing (.30-06)

3. Provide combined performances for indicated requirements, with each performance surviving combined attacks within rating limitations of performance, but recognizing that certain forms of attack may result in severe damage to units, even though repelled successfully, leading to need for replacement of units, or of damaged elements of units.

C. Air Flow Capability:

1. Minimum free area: 33 percent. Free area calculation must include allowances for all airflow obstructions (e.g., insect screen, bird screen, louvers, structural/support framing, etc.).
2. Maximum intake pressure drop: 3.8 mm (0.15 in) water gage at face velocity of 55 meters/min (180 ft/min).
3. Maximum discharge pressure drop: 7.5 mm (0.29 in) water gage at face velocity of 80 meters/min (265 ft/min).
4. Note: Testing is typically performed at a specified free area velocity (airflow through free area of louver), which is significantly higher than face velocity (airflow through framed opening without louver).

D. Normal environmental exposures when exposed to outdoor conditions: Except as otherwise indicated or applicable for type of security louver shown in each instance of use, achieve the following performances as defined by applicable industry standards, and as acceptable to Project Director/COR.

1. Water penetration: Configure and fabricate exterior exposed louvers to effectively repel normal range of exposures to precipitation.

2. Bird screens: Where indicated, equip louvers with bird screens so that maximum size opening for passage through louver is 12.7 mm in width, or 19 mm square. Except as otherwise indicated, locate on interior louver face, and provide access for cleaning/removal as acceptable to Project Director/COR.

E. Structural Performance: Security louver assemblies and their anchorage to the supporting building structure shall withstand the effects of wind loads determined as follows, with no permanent deformation when designed in according to ASCE 7-16, as adopted and amended by the OBO Building Code:

1. Basic Wind Speed: Shall be as indicated in the Structural Drawings.

2.2 MANUFACTURER/FABRICATOR

A. Certified Units: Provide units which are manufactured/fabricated by firms which have produced units identical with types required for this Project, which have been previously certified by Bureau of Diplomatic Security (DS) to comply with requirements for levels of resistance to attack specified or indicated, in accordance with Department of State, DS/PSP/PSD, Forced Entry and Ballistics Certification Standard SD-STD-01.01, Revision H.

2.3 SPECIAL APPLICATIONS:

A. Anti-Climb Performance: Based upon design criteria associated with building type or location within project, FE/BR louvers may be required to meet DOS anti-climb criteria.

1. While project design may adequately facilitate use of secondary louver outboard of FE/BR louver to achieve anti-climb, design must be coordinated through Project Director/COR and confirmed by OBO/CFSM/SM Physical Security Engineer, and must conform to all mechanical air flow project criteria.
2. Secondary louver design may be used to address both anti-climb and storm louver project requirements.

B. Hurricane-Resistant Louvers: In hurricane-prone regions, FE/BR louver louver design shall mitigate the effects of hurricane-driven precipitation.

1. While project design may adequately facilitate use of secondary louver outboard of FE/BR louver to address this precipitation risk, design must be coordinated through Project Director/COR and confirmed by OBO/CFSM/SM Physical Security Engineer, and must conform to all mechanical air flow project criteria.
2. Secondary louver design may be used to address both anti-climb and these hurricane-resistant louver requirements.

2.4 CORROSION RESISTANCE PERFORMANCE

A. Corrosion Risk: As indicated in project Contract (e.g., Statement of Work). The OBO Building Code Appendix W defined OBO Atmospheric Corrosivity Level for this site is **[Low] [Moderate] [Extreme]**. The atmospheric corrosion risk exposure risk type for a given component shall be as defined by OBO Building Code R101.1.2 (i.e., direct exterior, indirect exposure to exterior, and interior exposure only).

B. Corrosion Resistance Standards: Provide materials and finishes for the components in accordance with the material specifications of this Specification Section and the general material type as indicated by this article for the project-specific corrosion risk identified above or elsewhere in the Contract Documents.

C. Material Standards for Components for Interior Louvers: As applicable for the OBO Atmospheric Corrosivity Level (ACL) of site:

1. Mild Steel: hot-dipped galvanized coating; low, moderate, and extreme ACL.
2. Stainless Steel: low, moderate, and extreme ACL
3. Aluminum: low, moderate, and extreme ACL.

D. Material Standards for Components for Exterior Louvers: As applicable for the OBO Atmospheric Corrosivity Level (ACL) of site and for both direct exterior exposure and indirect exposure to the exterior:

1. Mild Steel: hot-dipped galvanized coating; low and moderate ACL.
2. Stainless Steel: low, moderate, and extreme ACL.
3. Aluminum: low, moderate, and extreme ACL.

2.5 MATERIALS, GENERAL REQUIREMENTS FOR MILD STEEL LOUVERS

A. Hot-Rolled Steel Sheets and Strips: ASTM A 569, commercial quality, pickled and oiled, except as otherwise indicated.

B. Cold-Rolled Steel Sheets: ASTM A 366, commercial quality, except as otherwise indicated.

C. Galvanized (Zinc-Coated) Steel Sheets: ASTM A 653, G90 zinc coating, mill phosphatized; commercial steel, except as otherwise indicated. Zinc-iron alloy-coated (galvannealed) steel sheet products are not permitted.

D. Stainless Steel Sheets where required for finish: AISI Type 316, complying with ASTM A 167; commercial quality, No. 4 directional polish.

E. Plates, Bars, Angles, and Channels: ASTM A36 or ASTM A572

F. Hollow Structural Sections (steel tubes): ASTM A500 or ASTM A1085

G. Supports and Anchors: Fabricate to endure required performances, but of not less than 1.5 mm sheet steel. For exterior wall assemblies, hot-dip zinc coat support/anchor units after fabrication in compliance with ASTM A 153, Class B.

H. Inserts, Bolts Fasteners: Standard units of strengths required to endure performances; hot-dip zinc coated where used in exterior wall assemblies in compliance with ASTM F2329.

I. Hot-Dip Galvanizing: All mild steel louver components must be hot-dip galvanized in accordance with ASTM A123.

2.6 MATERIALS, GENERAL REQUIREMENTS FOR STAINLESS STEEL LOUVERS

A. Stainless Steel Plates, Sheets, and Strips: AISI Type 316, 316L, 2101 or 2205 complying with ASTM A240/A240M or ASTM A895/A895M

B. Stainless Steel Bars and Shapes: AISI Type 316, 316L, 2101 or 2205 where welding is to be performed, complying with ASTM A276/A276M or A582/A582M

C. Stainless Steel Tubing: AISI Type 316, 316L, 2101 or 2205A1016/A1016M

D. Stainless Steel Wire and Rod: AISI Type 316, 316L, or as recommended by the manufacturer for AISI 2101 or 2205 steel, complying with ASTM A555/A555M

E. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers: AISI Type 316 (Alloy Group 2), complying with ASTM F593 and ASTM A594, or ASTM A193 and ASTM A194, or ASTM A320 and ASTM A194, or ASTM A1082; provide washers of compatible stainless steel alloy where appropriate.

2.7 MATERIALS, GENERAL REQUIREMENTS FOR ALUMINUM LOUVERS

A. Minimum Aluminum Extrusions: In compliance with FE/BR performance of tested assembly.

B. Aluminum Sheets, Plates, Bars, Tubes, and Shapes: Comply with Aluminum: ASTM B209 (ASTM B209M) stretcher-leveled aluminum alloy or ASTM B221 (ASTM B221M)

C. Minimum sheet thickness: Sheet one-piece 1.02 mm (0.040-inch)

D. Inserts, Bolts, Fasteners: Standard units of strengths required to endure performances; Stainless steel, grade shall match tested/certified condition. Provide compatible washer that prevents galvanic action. See paragraph below on “Frame to Subframe Attachments” for anchor bolt requirements.

1. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers: AISI Type 316 (Alloy Group 2), complying with ASTM F593 and ASTM A594, or ASTM A193 and ASTM A194, or ASTM A320 and ASTM A194, or ASTM A1082; provide compatible AISI Type 316 washers where appropriate.

E. Fasteners: Sizes and spacings as required to fulfill performance requirements, including strength-of-steel selections; finished to match steel louver members, except as otherwise indicated. Where fastener heads or nuts are exposed on forced-entry resistant faces of louvers, provide non-removable-type fastener units of stainless steel unless otherwise indicated; comply with ASTM A 320.

F. Inserts, Anchors, and Accessories: **[Hot-dip galvanized after fabrication, complying with ASTM A 2329.] [Stainless steel Type 316]** Provide concrete inserts of cast-iron or malleable-iron complying with ASTM A 47, or of fabricated steel. In addition to any restrictions or requirements indicated on the Construction Drawings, post-installed anchor systems proposed by the Contractor's delegated design shall each have ICC-ES Evaluation Report indicating conformance with current applicable ICC-ES Acceptance Criteria including, but not limited to, for cracked concrete for concrete substrate applications, seismic applications, and for the use in the specific substrate type and characteristics intended. Shop drawings and field work sketches shall clearly indicate critical embedment, spacing, and edge distance requirements and placement tolerances determined by the design.

G. Supports and Anchors: For wall assemblies, hot-dip zinc coat support/anchor units after fabrication in compliance with ASTM A 153, Class B

H. Frame to Subframe Attachment: Stainless steel, hot-dip, zinc-coated steel, or iron, complying with ASTM B 633 and ASTM F1941 for fasteners; provide sufficient mechanical properties that design conforms to the Part 2 Article on PERFORMANCE REQUIRMENTS.

1. All fasteners for louvers shall be socket head metric (Class 8.8) equivalent to SAE J429 Grade 5 or other appropriate high strength bolts and hardened nuts and washers as identified in the blast report or as needed to satisfy the performance requirements and comply with standard OBO specifications for FE/BR and Blast resistant products. If blast, or other requirements, result in changes to the tested FE/BR design, to include anchor or other material changes, the FE/BR vendor shall contact DS/PSP/RD for to determine if a technical review is required. Shop drawings should include the TR number, where applicable. Contractor's design shall provide appropriate corrosion prevention where dissimilar metals are in close proximity and to address the atmospheric corrosion performance requirements identified in this specification.

I. Welding Rods/Bare Electrodes: Provide type recommended by applicable AWS specifications, for metal/alloy being welded in each element of louver fabrication and installation.

J. Stainless Steel Flashing: Provide dead soft stainless steel sheet of gage indicated, but not less than 0.61 mm (24-gage, 0.0235 inches) thick; comply with ASTM A 167, **[Type 316]**.

2.8 FABRICATION AND ASSEMBLY

A. General: Fabricate, test, and preassemble security louver units at factory. Weld joints/seams in metal work to utilize full strength of each member in assembly to resist forces of attack to maximum. Comply with applicable AWS standards for welding workmanship, and grind exposed-to-view welds reasonably smooth. Provide welded-in-place steel reinforcements,

including anchorage devices, as indicated. Provide for disassembly of each expanse of louvered area to the extent necessary for shipment, handling, storage, and installation. Comply with AWS D1.1 Structural Welding Code for Steel. D1.6 for Stainless Steel and D1.2 for Aluminum. Fabricate to avoid leakage and entrapment of normal wind-driven precipitation, sand/dirt, and similar substances in atmosphere in configurations of louver blades, frames, and other elements. See the Part 1 Article on ACTION SUBMITTALS for participation requirements.

1. Fabrication: Except as otherwise indicated, fabricate louver assemblies entirely of steel, stainless steel, or aluminum shapes, plates, and bars; welding principal elements of assemblies for maximum strength, and resistance to security attack.

    a. Include supports, anchorages, and accessories required for complete secure assembly.
    b. Provide vertical support at spacings no further apart than used on the FE/BR tested sample.
    c. Join frame members to one another and to stationary louver aperture bar stock slats by welding, except where field bolted connections between frame members are made necessary by sized of louvers. Maintain equal slat spacing, including separation between slats and frames at head and sill to produce uniform appearance. The slanted slats or other approved configuration shall be designed to allow flow of air and privacy but to exclude rain, debris, or sun.
    d. Stainless Steel Welded Joint Treatment: At all welded joints in stainless steel assemblies, remove oxides, carbon precipitation, and weld spatter at or around welded joints and passivate surfaces in accordance with ASTM A380 and ASTM A967.

2. Load deflection isolation: Fabricate head and jamb anchorage system for each louver unit to ensure isolation of unit from absorbing or being subjected to vertical and lateral loading due to building structure deflections, caused by dead and live loading of the structure, including anticipated seismic deflections as indicated in the Structural Movements Narrative. Mounting shall be designed to allow movements needed for isolation from structure while maintaining the as tested design for anchors.
3. Bird Screens: Fabricate of stainless steel material with maximum size opening for passage through louver that is 12.7mm in width, or 19mm square. Screens shall be located on inside face of exterior louvers and shall be secured to louver frames to permit removal and cleaning. Screens are not required on louvers inside of the building (i.e., non-exterior louvers)

B. Sub-Frames: Provide steel sub-frames for all FE or FE/BR louvers for installation at concrete, masonry, and other non-steel rough openings and for structural steel openings where the depth is less than the louver frame depth. Sub-frames and their anchorages to the supporting building structure shall be designed by the louver supplier and shown in the louver shop drawings. No steel element to receive a threaded fastener shall be less than 12 mm (1/2 inch) thick. Embedded plates with headed steel studs shall not be less than 12 mm thick and have depth not less than the louver frame depth. Embed plates shall be designed to receive bolts for attaching the louvers and shall be detailed to ensure the bolts do not bottom out and the that the proper installation torque can be achieved. Coordinate the sub-frame anchor locations with the louver frame bolt hole locations. When within blast envelope of structure, in addition to the structural and FEBR

performance requirements the sub-frame design shall conform to blast design and anchorage requirements.

1. Steel sub-frame material shall conform to:

    a. Plates and Bars: ASTM A36 or ASTM A572
    b. Channels and Angles: ASTM A36 or ASTM A572
    c. Hollow Structural Sections ("steel tubes"): ASTM A500 or ASTM A1085.

2. Post-installed Anchors: In addition to any restrictions or requirements indicated on the Construction Drawings, post-installed anchor systems proposed by the Contractor's delegated design shall each have ICC-ES Evaluation Report indicating conformance with current applicable ICC-ES Acceptance Criteria including, but not limited to, for cracked concrete for concrete substrates, seismic applications, and for the use in the specific substrate type and characteristics intended. Shop drawings and field sketches shall clearly indicate critical embedment, spacing, and edge distance requirements and placement tolerances determined by the design.
3. Shipping and Handling: Steel sub-frame shall be assembled and braced by manufacturer prior to shipping to avoid out of plane deformations during transportation. Where sub-frames are hot -dipped galvanized, temporary supports shall be designed and detailed to minimize damage to the galvanized surfaces during use and removal.
4. Contractor shall install steel sub-frames plumb and square. Contractor shall ensure that installation, or concrete pouring do not exceed the installation tolerances of the supported door system.
5. All sub-frames without adjustability shall be drilled and tapped in the field.
6. For New Concrete Substrates: Attach steel sub-frame the concrete substrate with embedded anchors with minimum 12mm x 150mm steel studs, spaced no less than 450 mm on center. Final sub-frame shop drawings, product data, and associated delegated design calculations shall be approved by OBO/SEB prior to fabrication and shipment.

    a. Exterior sub-frames shall be hot-dipped galvanized for corrosion resistance in accordance with ASTM A123.
    b. Interior sub-frames shall be hot-dipped galvanized in accordance with ASTM A123 when cast in place.

7. **[For Masonry Substrates: Provide steel sub-frame, typically a plate, tube, or channel that has a minimum 12-mm thickness for the anchors and a minimum 150 mm width and as determined per the blast design, when blast is a requirement. Post-installed chemical anchors in hollow masonry substrates shall use appropriate screen tubes provided by the anchor system's manufacturer installed in conformance with the Manufacturer's Printed Installation Instructions, and coordinated with the delegated design calculations to meet the performance requirements.]**
8. **[For Existing Concrete Substrates: Provide steel sub-frame frame and attach to the concrete substrate with post-installed anchors with minimum 12 mm diameter, embedded no less than 200 mm, spaced no greater than 300 mm on-center, with edge distances not less than required by the anchor system manufacturer, installed in conformance with the Manufacturer's Printed Installation Instructions, and**

coordinated with the delegated design calculations to meet the performance requirements.]

2.9 FINISHES

A. Finish Standards for Louver: As applicable for risk associated with Atmospheric Corrosivity Level (ACL) for the project location. Refer to the Part 2 Article on CORROSION RESISTANCE PERFORMANCE for acceptable component materials for various ACL.

1. Stainless Steel: These components do not require coating, but may be coated for aesthetic purposes. See Section 099602 “High-Performance FE/BR Coatings” where coatings are applied.
2. Fluoropolymer Coatings: Fluoropolymer coatings may be used over any acceptable base metal. See Section 099602 “High-Performance FE/BR Coatings.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine prepared substrate openings to receive security louver units. Check anchorages for location and coordination of face plans between walls and louver units. Check clearances provided for isolation of louver units from building movements and deflections, and for joint sealer applications.

B. Apply bituminous paint coating, in 30-mil (0.76-mm) thickness, on louver sub-frame edge members, where required to be in contact with cementitious substrates or other dissimilar materials. Confine coating to surfaces not exposed to view, and allow to dry nominally before installation of units.

C. Provide through wall flashing at all louvers. Flashing to provide weather and watertight seal.

3.2 INSTALLATION

A. General: Install Security Louver Assemblies in accordance with approved shop drawings, manufacturer's data and instructions, and requirements of these specifications and the attached Certificate of Compliance

B. Sequencing and Timing Requirements: At the time agreed upon with Project Director/COR, proceed with installation of fabricated metal louver units. Sequence installation work to achieve proper application for each element indicated, in manner which will produce maximum resistance to indicated forms of attack and weather.

1. Coordinate installation of louver units with installation of expansion joint materials, isolators, joint fillers, spacer strips, tapes, gaskets, sealants, sub-frame stops, and other elements as indicated. Produce tightly fitted, weather resistant, securely supported louver

unit installation, achieving required performances. Tighten bolts for maximum shear and tensile strength, for resisting forces indicated. Comply with requirements in Division 07 section on joint sealants and Division 08 section on glazing. Comply with Fabricator's instructions and recommendations.

C. Coordinate installation of louver units in sub-frames with installation of expansion joint materials, isolators, joint fillers, spacer strips, tapes, gaskets, sealants, backer rods, sub-frame stops, and other elements indicated. Install louver units uniformly to lines and elevations indicated, plumb and level, true to plane of optical reflection. Produce tightly fitted, weather resistant security louver units achieving required performances. Comply with Fabricator's instructions for final assembly and installation. Install anchor bolts and devices as indicated, exercising care to shim and tighten against substrates without distorting or deflecting frames from intended lines. Comply with requirements in Division 07 section on joint sealants.

D. Place installation accessory items as shown and as required for unit installations, including flashings, shims, fillers, bedding materials, and anchorage accessories. Prepare openings for unit interfaces with other work.

E. Install bird screen only on inside face of exterior most louver when louvers are installed in tandem.

F. Anchorage: The louver manufacturer shall provide anchors appropriate for substrate to which louver frame and sub-frame is to be fastened. Louver frames shall have pre-drilled, vertically slotted bolt hole patterns not to exceed as tested condition. The Contractor shall verify substrates involved, and supply any special fastening tools (e.g., special drill or bit) required by anchoring system. The anchor shall be acceptable for shock/short duration loading, and have potential for removal and re-installation during life of building. Exercise extreme care in tightening of fasteners at lines of anchorage where building deflections are indicated to be accommodated without transferring loading onto louver units.

1. Avoid cutting rebar during concrete sub-frame installation.
2. Provide 1.5 mm (1/16 inch) thick shims with break-off tabs for rough opening (RO) frame clearance.

G. Overcoat Painting: Refer to Division 09 section for painting for final overcoating on metal framing and trim members of fenestration units; not work of this Section.

H. Interface joint sealers: Refer to applicable Division 07 sections for installation of exposed joint sealant beads and related materials as indicated; not work of this Section.

I. [Field Touch-up: For projects that include coating of aluminum, refer to Section 099602, "High-Performance FE/BR Coatings."; these may require touch-up of installed louvers.]

3.3 FIELD QUALITY CONTROL

A. The manufacturer's technical representative shall observe and advise the crew during their installation of the first three FE/BR louvers. Upon completion of the installation of each of the three initial FE/BR louvers, the manufacturer's technical representative shall inspect the work and

direct the crew in any correction or modifications required for acceptable performance of the units.

B. For unique site conditions, the manufacturer's technical representative shall also be responsible for observing and inspecting the installation of FE/BR louvers, beyond the initial three louvers, as necessary to ensure that the installation crew is adequately prepared for installation. Contractor is responsible for documenting the installation of the unique installation on the "Certificate of Compliance" and for photographing said conditions (and anything that would be hidden after the installation).

3.4 CLEANING AND PROTECTION

A. General: When other work in area(s) of security louver installations has been completed, and when authorized by Project Director/COR, proceed with final cleaning of units. Remove protective coverings and residue of adhesives. Repair minor abrasions, and replace substantially damaged work as requested by Project Director/COR. Clean exposed coatings in accordance with instructions and recommendations of both coating Manufacturer and unit Fabricator. Test operating parts to show compliance with requirements; correct operational deficiencies as directed; lubricate bearings and remove excess lubrication.

END OF SECTION 089117

Certificate of Compliance

FE/BR Louver Assemblies
Louver Number _____
(per Construction Documents)

The Contractor shall complete the Certificates of Compliance in full prior to acceptance of the FE/BR products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager. When there is no QC Manager then the Contractor's Project Manager shall complete the form.

The DOS Approving Official (OBO/CFSM/SM/SEB, OBO/CFSM/SM/SOD/PSO, OBO/CFSM/CM, Post Facility Officer, or DOS representative appointed by the COR) will review each Certificate of Compliance for completeness.

DESCRIPTION – TRAINING & OTHER DUTIES OF REPRESENTATIVE/ LEADER

1	The manufacturer's technical representative (or Team Leader as allowed by the Part 1 Article on QUALITY ASSURANCE) was on site during the initial stages of installation and for site-specific unique conditions as required. Team installing security louvers has received training. See the requirements for the representative or leader in the Part 1 Article on QUALITY ASSURANCE.	**Representative's [Installer Team Leader's when there is no manufacturer's technical representative] Name/ Date:**

	DESCRIPTION - GENERAL	**INSTALLER TEAM LEAD: INITIALS/ DATE**	**CONTRACTOR QC MANAGER: INITIALS/ DATE**
2	Each sub-frame has been installed level, plumb and square.		
3	All pre-fabricated sub-frame assemblies, to include embeds, have been factory welded together.		
4	Employees performing the installation meet the specified training and experience qualifications.		

	DESCRIPTION - GENERAL	INSTALLER TEAM LEAD: INITIALS/ DATE	CONTRACTOR QC MANAGER: INITIALS/ DATE
5	All temporary bolts have been replaced with permanent bolts.		
6	All frame bolts have been torqued per manufacturer's specifications. Shims have been inserted at all bolt locations, minimum one shim per bolt.		
7	Maximum gap at shim space is no more than 6.5mm (1/4") or as per the manufacturer's specifications based on the tested and DS certified assembly. A minimum of one shim at each bolt location has been provided.		
8	Frame bolts/screws are per the approved shop drawings. When within a blast envelope of a structure, blast design and anchorage requirements have been met.		
9	All product bolts, screws and anchors are metric products.		
10	Separate pieces of ballistic trim have been installed, as indicated in the approved shop drawings.		
11	Ballistic trim bars have been secured/screwed to the sub-frame and not the louver frame.		
12	The manufacturer has provided two metal ID plates for each louver that has machine applied letters and numbers.		

Installer Team Lead:	**Contractor's QC Manager:**
Printed Name: _____	Printed Name: _____
Signature: _____	Signature: _____
Initials: _____	Initials: _____

Noted Variances:

_____

_____

_____

_____

_____

_____

_____

DOS Approving official approval/rejection/further action indicated for each variance:

_____

_____

_____

_____

_____

_____

_____

[1] [2] DOS Approving Official: _____ Date: _____

Office: _____ Name: _____ Position: _____

[1] DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2] Certificate of Compliance is required to be included in the close out submittal.

SECTION 092400 - CEMENT PLASTERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior vertical plasterwork (stucco).
2. Exterior horizontal and nonvertical plasterwork (stucco).
3. Interior vertical plasterwork.
4. Interior horizontal and nonvertical plasterwork.

B. Material Index / Material Codes Include:

1. PSW-[##] <(VERTICAL) PLASTER WALL.>
2. PSC-[##] <(HORIZONTAL AND NONVERTICAL) PLASTER CEILING OR SOFFIT.>

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Color Charts: Submit color charts showing full range of manufacturer's standard colors, for selection of colors for finish coats having integral color.

C. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

D. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

E. Samples for Verification: For each type of factory-prepared finish coat and for each color and texture specified, 305 by 305 mm (12 by 12 inches). Prepare on rigid backing.

1. Color Charts: Submit color charts showing full range of manufacturer's standard colors, for Project Director/COR selection of colors, based on input from the A/E of Record, for finish coats having integral color.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for each substrate and finish texture indicated for cement plastering, including accessories.

a. Size: **[9 sq. m (100 sq. ft.)]** <**Insert dimension**> in surface area.

2. For interior plasterwork, simulate finished lighting conditions for review of mockups.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover. Keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 FIELD CONDITIONS

A. Comply with ASTM C 926 requirements.

B. Exterior Plasterwork:

1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
2. Apply plaster when ambient temperature is greater than 4.4 deg C (40 deg F).
3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.

C. Interior Plasterwork: Maintain room temperatures at greater than 4.4 deg C (40 deg F) for at least 48 hours before plaster application, and continuously during and after application.

1. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.

2. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

D. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Where indicated, provide cement plaster assemblies identical to those of assemblies tested for fire resistance according to ASTM E119 by a qualified testing agency.

2.2 METAL LATH

A. Expanded-Metal Lath: ASTM C 847, cold-rolled carbon-steel sheet with ASTM A 653/A 653M, Z180 (G60), hot-dip galvanized-zinc coating.

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25]** <**Insert value**> percent.
2. Diamond-Mesh Lath: **[Flat] [Self-furring]**, **[1.4 kg/sq. m (2.5 lb/sq. yd.)] [1.8 kg/sq. m (3.4 lb/sq. yd.)]**.

3. Flat-Rib Lath: Rib depth of not more than 3 mm (1/8 inch), [**1.5 kg/sq. m (2.75 lb/sq. yd.)**] [**1.8 kg/sq. m (3.4 lb/sq. yd.)**].

4. 10-mm (3/8-Inch) Rib Lath: [**1.8 kg/sq. m (3.4 lb/sq. yd.)**] [**2.2 kg/sq. m (4 lb/sq. yd.)**].

B. Wire-Fabric Lath:

1. Welded-Wire Lath: ASTM C 933; self-furring, [**0.8 kg/sq. m (1.4 lb/sq. yd.)**] [**1.1 kg/sq. m (1.95 lb/sq. yd.)**].
2. Woven-Wire Lath: ASTM C 1032; self-furring, with stiffener wire backing, 0.8 kg/sq. m (1.4 lb/sq. yd.).

C. Paper Backing: FS UU-B-790a, Type I, **[Grade D, Style 2 vapor-permeable paper] [Grade B, Style 1a vapor-retardant paper]** <**Insert requirements**>.

1. Provide paper-backed lath **[unless otherwise indicated] [at exterior locations] [in locations indicated on Drawings] <Insert locations>**.

2.3 ACCESSORIES

A. General: Comply with ASTM C 1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:

1. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, Z180 (G60), hot-dip galvanized-zinc coating.

2. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A653/A653M, G60 (Z180) zinc coating.
3. Cornerbeads: Fabricated from **[zinc] [or] [zinc-coated (galvanized) steel]**.

a. Smallnose cornerbead with expanded flanges; use unless otherwise indicated.
b. Smallnose cornerbead with perforated flanges; use on curved corners.
c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
d. Bullnose cornerbead, radius 19 mm (3/4 inch) minimum, with expanded flanges; use at locations indicated on Drawings.

4. Casing Beads: Fabricated from **[zinc] [or] [zinc-coated (galvanized) steel]**; square-edged style; with expanded flanges.
5. Control Joints: Fabricated from **[zinc] [or] [zinc-coated (galvanized) steel]**; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
6. Expansion Joints: Fabricated from **[zinc] [or] [zinc-coated (galvanized) steel]**; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
7. Two-Piece Expansion Joints: Fabricated from **[zinc] [or] [zinc-coated (galvanized) steel]**; formed to produce slip-joint and square-edged reveal that is adjustable from 6 to 16 mm (1/4 to 5/8 inch) wide; with perforated flanges.

2.4 MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 13 mm (1/2 inch) long, free of contaminants, manufactured for use in cement plaster.

C. Bonding Compound: ASTM C 932.

D. Fasteners for Attaching Metal Lath to Substrates: ASTM C 1063.

E. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 1.21-mm (0.0475-inch) diameter unless otherwise indicated.

F. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

2.5 PLASTER MATERIALS **[PSC-[##] AND/OR PSW-[##]]**

A. Portland Cement: ASTM C 150/C 150M, **[Type I] [Type II]**.

1. Color for Finish Coats: **[White] [Gray]**.

B. Masonry Cement: ASTM C 91, Type N.

1. Color for Finish Coats: **[White] [Gray]**.

C. Plastic Cement: ASTM C 1328.

D. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color **[to match Project Director/COR's sample]** <**Insert requirements**>.

E. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.

F. Sand Aggregate: ASTM C 897.

1. Color for Job-Mixed Finish Coats: **[White] [In color matching Project Director/COR's sample]**.

G. Perlite Aggregate: ASTM C 35.

H. Exposed Aggregates for Finish Coats: **[For marblecrete finish, clean, sound, crushed marble matching color and size gradation of Project Director/COR's sample] <Insert requirements>**.

I. Ready-Mixed Finish-Coat Plaster: Mill-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.

1. Color: **[Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

J. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems formulated with colorfast mineral pigments and fine aggregates; for use over cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.

1. Color: **[Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

2.6 PLASTER MIXES

A. General: Comply with ASTM C 926 for applications indicated.

1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 0.6 kg of fiber/cu. m (1 lb of fiber/cu. yd.) of cementitious materials.

B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:

1. Portland Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and **[0 to 3/4] [3/4 to 1-1/2]** parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part portland cement and **[0 to 3/4] [3/4 to 1-1/2]** parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

2. Masonry Cement Mixes:

a. Scratch Coat: Mix 1 part masonry cement and 2-1/2 to 4 parts aggregate.
b. Brown Coat: Mix 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

3. Portland and Masonry Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

4. Plastic Cement Mixes:

a. Scratch Coat: Mix 1 part plastic cement and 2-1/2 to 4 parts aggregate.
b. Brown Coat: Mix 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.

5. Portland and Plastic Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

C. Base-Coat Mixes for Use over **[Unit Masonry] [and] [Concrete]**: Single base (scratch) coat for two-coat plasterwork on low-absorption plaster bases as follows:

1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
2. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
3. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

D. Base-Coat Mixes for Use over **[Unit Masonry] [and] [Concrete]**: Single base (scratch) coat for two-coat plasterwork on high-absorption plaster bases as follows:

1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
2. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
3. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
4. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

E. Job-Mixed Finish-Coat Mixes:

1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and **[3/4 to 1-1/2] [1-1/2 to 2]** parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
2. Masonry Cement Mix: Use 1 part masonry cement and 1-1/2 to 3 parts aggregate.
3. Portland and Masonry Cement Mix: For cementitious materials, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
4. Plastic Cement Mix: Use 1 part plastic cement and 1-1/2 to 3 parts aggregate.

F. Factory-Prepared Finish-Coat Mixes: For **[ready-mixed finish-coat plasters] [acrylic-based finish coatings]**, comply with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

B. Prepare smooth, solid substrates for plaster according to ASTM C 926.

3.3 INSTALLATION, GENERAL

A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.

B. Sound-Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.

3.4 INSTALLING METAL LATH

A. Metal Lath: Install according to ASTM C 1063.

1. Partition Framing and Vertical Furring: Install **[flat-diamond-mesh] [flat-rib] [welded-wire] [woven-wire]** lath.
2. Flat-Ceiling and Horizontal Framing: Install **[flat-diamond-mesh] [flat-rib] [10-mm (3/8-inch) rib] [welded-wire] [woven-wire]** lath.

3. Curved-Ceiling Framing: Install **[flat-diamond-mesh] [welded-wire] [flat-woven-wire]** lath.
4. On Solid Surfaces, Not Otherwise Furred: Install self-furring, **[diamond-mesh] [welded-wire] [woven-wire]** lath.

3.5 INSTALLING ACCESSORIES

A. Install according to ASTM C 1063 and at locations indicated on Drawings.

B. Reinforcement for External (Outside) Corners:

1. Install **[lath-type, external-corner reinforcement] [cornerbead]** at exterior locations.
2. Install cornerbead at interior locations.

C. Control Joints: Locate as approved by Project Director/COR for visual effect and as follows:

1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:

   a. Vertical Surfaces: 13.4 sq. m (144 sq. ft.).
   b. Horizontal and Other Nonvertical Surfaces: 9.3 sq. m (100 sq. ft.).

2. At distances between control joints of not greater than 5.5 m (18 feet) o.c.
3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
4. Where control joints occur in surface of construction directly behind plaster.
5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.6 PLASTER APPLICATION

A. General: Comply with ASTM C 926.

1. Do not deviate more than plus or minus 6 mm in 3 m (1/4 inch in 10 feet) from a true plane in finished plaster surfaces when measured by a 3-m (10-foot) straightedge placed on surface.
2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

B. Bonding Compound: Apply on **[unit masonry] [and] [concrete]** substrates for direct application of plaster.

C. Walls; Base-Coat Mixes for Use over Metal Lath: For scratch and brown coats, for three-coat plasterwork with 19-mm (3/4-inch) total thickness, as follows:

1. Portland cement mixes.
2. Masonry cement mixes.
3. Portland and masonry cement mixes.
4. Plastic cement mixes.
5. Portland and plastic cement mixes.

D. Ceilings; Base-Coat Mixes for Use over Metal Lath: For scratch and brown coats, for three-coat plasterwork and having **[13-mm (1/2-inch) total thickness] [19-mm (3/4-inch) total thickness for metal lath on concrete]**, as follows:

1. Portland cement mixes.
2. Masonry cement mixes.
3. Portland and masonry cement mixes.
4. Plastic cement mixes.
5. Portland and plastic cement mixes.

E. Walls; Base-Coat Mix: For base (scratch) coat, for two-coat plasterwork and having **[10-mm (3/8-inch) thickness on masonry] [6-mm (1/4-inch) thickness on concrete]**, as follows:

1. Portland cement mix.
2. Masonry cement mix.
3. Portland and masonry cement mix.
4. Plastic cement mix.
5. Portland and plastic cement mix.

F. Ceilings; Base-Coat Mix: For base (scratch) coat, for two-coat plasterwork and having 6-mm (1/4-inch) thickness on concrete, as follows:

1. Portland cement mix.
2. Masonry cement mix.
3. Portland and masonry cement mix.
4. Plastic cement mix.
5. Portland and plastic cement mix.

G. Plaster Finish Coats: Apply to provide **[float] [dash] [scraped trowel-textured] [skip trowel-textured] [brocade (knock-down dash)] [trowel sweep] [combed] [sacked (California mission)] [English] [marblecrete] <Insert requirements>** finish to match Project Director/COR's sample.

H. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.

I. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.

J. Concealed Interior Plasterwork:

1. Where plaster application is concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.

2. Where plaster application is concealed above suspended ceilings and in similar locations, omit finish coat.
3. Where plaster application is used as a base for adhesive application of tile and similar finishes, omit finish coat.

3.7 PLASTER REPAIRS

A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.8 CLEANING AND PROTECTION

A. Remove temporary protection and enclosure of other work after plastering is complete. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 092400

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.
3. Sound-rated construction.
4. Tile backing panels.
5. Gypsum board finishing.
6. Trim and accessories.

B. Related Requirements:

1. Division 06 Section on "Sheathing" for gypsum sheathing for exterior walls.
2. Division 07 Section on "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
3. Division 09 Section on "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
4. Division 09 Section on "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
5. Division 09 Section on "Gypsum Veneer Plastering" for gypsum base for veneer plaster and for other components of gypsum-veneer-plaster finishes.
6. Division 09 Section on "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 PREINSTALLATION MEETINGS

1. Preinstallation Conference: Conduct conference at the Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

2. Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
3. Credit EQ 4.1: For adhesives and sealants used inside the weatherproofing system, include printed statement of VOC content.
4. Provide reports required by Division 01 Section “Construction Waste Management”.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch (300-mm) long length for each trim accessory indicated.

D. Shop Drawings: Submit Shop Drawings of interior wall elevations indicating control joint locations.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated by an independent testing and inspecting agency acceptable to authorities having jurisdiction, and according to one of the following standards:

1. ASTM E 119 "Test Methods for Fire Tests of Building and Construction Materials."
2. ISO 834, Parts 1, 3-9 “Fire Resistance Tests-Elements of Building Construction."
3. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory.

B. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to one of the following standards:

1. ASTM E 90 "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."
2. BS EN ISO 140-1:1998 Acoustics: Measurement of Sound Insulation in Buildings and Building Elements Part 1: Requirements for Laboratories.
3. BS EN ISO 140-3: 1995 Acoustics: Measurement of Sound Insulation in Buildings and Building Elements Part 3: Laboratory Measurements of Airborne Sound Insulation of Building Elements.”

   a. Classified according to ASTM E 413 "Classification for Rating Sound Insulation" by a qualified independent testing agency.

4. STC-Rated Assemblies: Indicated by design designations from Gypsum Association's GA-600, "Fire Resistance Design Manual."

C. Mockups: Before finishing gypsum board assemblies, build mockups of at least 9 sq. m (100 sq. ft.) in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for the following:

a. Each level of gypsum board finish indicated for use in exposed locations.
b. Each texture finish indicated.

2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PERFORMANCE REQUIREMENTS

A. Deflection Limits:

1. Tile or Stone-Faced Assemblies: L/360.
2. All Other Wall Assemblies: L/240.
3. Ceiling Assemblies: L/240.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier. Comply with Gypsum Association publication GA-238-03 "Guidelines for Prevention of Mold Growth on Gypsum Board" for transportation, storage and handling requirements.

B. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Thickness: 15.9 mm (5/8 inch).
2. Long Edges: Tapered.

B. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: 15.9 mm (5/8 inch).
2. Long Edges: Tapered.

C. Flexible Gypsum Board: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Thickness: 6.4 mm (1/4 inch).
2. Long Edges: Tapered.

D. Gypsum Ceiling Board: ASTM C1396/C1396M.

1. Thickness: 12.7 mm (1/2 inch).
2. Long Edges: Tapered.

E. [Foil-Backed Gypsum Board: ASTM C1396/C1396M.

1. Core: [As indicated on Drawings] [9.5 mm (3/8 inch), regular type] [12.7 mm (1/2 inch), regular type] [15.9 mm (5/8 inch), Type X] [Type C as required by fire-resistance-rated assembly indicated on Drawings].
2. Long Edges: Tapered.]

F. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.

1. Core: **[As indicated on Drawings] [15.9 mm (5/8 inch), regular type] [15.9 mm (5/8 inch), Type X]**.
2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds **[Level 1] [Level 2] [Level 3]** requirements.
3. Indentation: ASTM C1629/C1629M, meets or exceeds **[Level 1] [Level 2] [Level 3]** requirements.
4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds **[Level 1] [Level 2] [Level 3]** requirements.
5. Long Edges: Tapered.
6. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

G. Impact-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.

1. Core: **[As indicated on Drawings] [15.9 mm (5/8 inch), regular type] [15.9 mm (5/8 inch), Type X]**.
2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds **[Level 1] [Level 2] [Level 3]** requirements.
3. Indentation: ASTM C1629/C1629M, meets or exceeds **[Level 1] [Level 2] [Level 3]** requirements.
4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds **[Level 1] [Level 2] [Level 3]** requirements.
5. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds **[Level 1] [Level 2] [Level 3]** requirements according to test in Annex A1.
6. Long Edges: Tapered.
7. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

H. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: **[As indicated] [15.9 mm (5/8 inch), regular type] [15.9 mm (5/8 inch), Type X]**.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 SPECIALTY GYPSUM BOARD

A. Gypsum Board, Type C: ASTM C1396/C1396M. Manufactured to have increased fire-resistive capability.

1. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
2. Long Edges: Tapered.

B. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.

1. Core: **[As indicated] [12.7 mm (1/2 inch), regular type] [12.7 mm (1/2 inch), Type C] [15.9 mm (5/8 inch), Type X] [15.9 mm (5/8 inch), abuse resistant]**.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

C. Acoustically Enhanced Gypsum Board: ASTM C1396/C1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.

1. Core: **[As indicated] [12.7 mm (1/2 inch), regular type] [12.7 mm (1/2 inch), Type X] [15.9 mm (5/8 inch), regular type] [15.9 mm (5/8 inch), Type X] [35 mm (1-3/8 inch), regular type]**.
2. Long Edges: Tapered.

D. Skim-Coated Gypsum Board: ASTM C1396/C1396M. Manufactured with a factory-applied skim coat.

1. Core: **[As indicated] [15.9 mm (5/8 inch), regular type] [15.9 mm (5/8 inch), Type X]**.
2. Long Edges: Tapered.

2.5 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Core: **[As indicated] [12.7 mm (1/2 inch), regular type] [15.9 mm (5/8 inch), Type X]**.

B. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.

1. Core: **[As indicated] [12.7 mm (1/2 inch), regular type] [15.9 mm (5/8 inch), Type X]**.

2.6 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.

1. Core: **[As indicated on Drawings] [12.7 mm (1/2 inch), regular type] [15.9 mm (5/8 inch), Type X]**.
2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

B. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.

1. Thickness: **[6.4 mm (1/4 inch)] [12.7 mm (1/2 inch)] [15.9 mm (5/8 inch)] [As indicated]**.
2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

C. Water-Resistant Gypsum Backing Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Core: **[As indicated on Drawings] [12.7 mm (1/2 inch), regular type] [15.9 mm (5/8 inch), Type X] [Type C as required by fire-resistance-rated assembly indicated on Drawings]**.

2.7 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.
e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Expansion (control) joint.
g. Curved-Edge Cornerbead: With notched or flexible flanges.
h. Base-of-Wall Galvanized Moisture Barrier Trim: Galvanized-steel sheet, 2 inches (50 mm) high.

B. Exterior Trim: ASTM C1047.

1. Material: Hot-dip galvanized-steel sheet, or rolled zinc.
2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221 (ASTM B221M), Alloy 6063-T5.
2. Finish: **[Corrosion-resistant primer compatible with joint compound and finish materials specified] <Insert requirements for Class II anodic finishes and factory-painted, baked-enamel finishes>**.

2.8 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints**[, rounded or beveled panel edges,]** and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use **[setting-type taping] [drying-type, all-purpose]** compound.

   a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use **[setting-type, sandable topping] [drying-type, all-purpose]** compound.
4. Finish Coat: For third coat, use **[setting-type, sandable topping] [drying-type, all-purpose]** compound.
5. Skim Coat: For final coat of Level 5 finish, use **[setting-type, sandable topping compound] [drying-type, all-purpose compound] [high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish]**.

D. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
2. Cementitious Backer Units: As recommended by backer unit manufacturer.

3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.9 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.84 to 2.84 mm (0.033 to 0.112 inch) thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Thermal Insulation: As specified in Division 07 Section on "Thermal Insulation."

F. Vapor Retarder: As specified in Division 07 Section on "Vapor Retarders."

2.10 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant that effectively reduces airborne sound transmission through perimeter joints and openings in building construction. Comply with the following:

1. ASTM C 834 "Standard Specification for Latex Sealants" as demonstrated by testing representative assemblies according to ASTM E 90 "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."
2. For adhesive and sealant applications that are inside the weatherproofing system, comply with the Division 01 Section on Sustainable Design Requirements limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) if credit pursued by contractor.
3. Provide STC rating as indicted in the drawings.

B. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.

1. For adhesive and sealant applications that are inside the weatherproofing system, comply with the Division 01 Section on Sustainable Design Requirements limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) if credit pursued by contractor.
2. Provide STC rating as indicted in the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Install in accordance with reference standards and manufacturer's instructions, and as required to comply with seismic requirements.

B. Gypsum Board Application and Finishing Standards: Comply with one of the following:

1. ASTM C840 "Standard Specification for Application and Finishing of Gypsum Board" and GA-216 "Specifications for the Application and Finishing of Gypsum Board" published by the Gypsum Association.

C. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1.5 mm (1/16 inch) of open space between panels. Do not force into place.

E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

F. Form control and expansion joints with space between edges of adjoining gypsum panels.

G. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and structural members; allow 6.4- to 9.5-mm- (1/4- to 3/8-inch-) wide joints to install sealant.

H. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 6.4- to 12.7-mm- (1/4- to 1/2-inch-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

I. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

1. ASTM C 919 "Standard Practice for Use of Sealants in Acoustical Applications."

K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels [**vertically (parallel to framing)**] [**horizontally (perpendicular to framing)**] unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

   a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

   b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 400 mm (16 inches) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

C. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

D. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 300-mm (12-inch) long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 400 mm (16 inches) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 300-mm (12-inches) o.c.

3.4 INSTALLATION OF EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with 6.4-mm (1/4-inch) open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

3.5 INSTALLATION OF TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated on the Drawings. Install with 6.4-mm (1/4-inch) gap where panels abut other construction or penetrations.

B. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated.

C. Water-Resistant Backing Board: Install where indicated with 6.4-mm (1/4-inch) gap where panels abut other construction or penetrations.

D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.6 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Project Director/COR, based on input from the A/E of Record for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners**[unless otherwise indicated]**.
2. Bullnose Bead: Use **[at outside corners] [where indicated] <Insert requirements>**.
3. LC-Bead: Use **[at exposed panel edges] <Insert requirements>**.
4. L-Bead: Use **[where indicated] <Insert requirements>**.
5. U-Bead: Use **[at exposed panel edges] [where indicated] <Insert requirements>**.
6. Curved-Edge Cornerbead: Use at curved openings.

D. Exterior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use **[at exposed panel edges] <Insert requirements>**.

E. Aluminum Trim: Install in locations **[indicated on Drawings] <Insert requirements>**.

3.7 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints**[, rounded or beveled edges,]** and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile and panels that are substrate for acoustical tile.
3. Level 3: Where indicated on Drawings.
4. Level 4: Standard finish, unless otherwise noted.

a. Primer and its application to surfaces are specified in Division 09 Section on "Interior Painting."

5. Level 5: **[Where indicated on Drawings] <Insert locations>**. Provide level 5 finish as standard finish for Finish Code A1 and A2 where noted in Finish Code notes.

a. Primer and its application to surfaces are specified in Division 09 Section on "Interior Painting."

E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.8 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceramic mosaic tile.
2. Quarry tile.
3. Pressed floor tile.
4. Porcelain tile.
5. Glazed wall tile.
6. Stone thresholds.
7. Waterproof membrane**[for thinset applications**].
8. Crack isolation membrane.
9. Metal edge strips.

B. Material Index / Material Codes Include:

1. TCB-[##], TCF-[##], TCW-[##] <CERAMIC TILE BASE, FLOOR, WALL.>
2. TQB-[##], TQF-[##], TQW-[##] <(QUARRY TILE BASE, FLOOR, WALL.>
3. TPB-[##], TPF-[##], TPW-[##] <(PORCELAIN TILE BASE, FLOOR, WALL.>
4. TGB-[##], TGW-[##] <(GLASS TILE WALL.>
5. TSB-[##], TSF-[##], TSW-[##] <(STONE TILE BASE, FLOOR, WALL.>
6. STG-[##] <STONE THRESHOLD.>
7. GTG-[##] <GROUT.>

C. Related Requirements:

1. **[Division 07 Section on "Self-Adhering Sheet Waterproofing"] [Division 07 Section on "Elastomeric Sheet Waterproofing"] [Division 07 Section on "Thermoplastic Sheet Waterproofing"] [Division 07 Section on "Hot Fluid-Applied Rubberized Asphalt Waterproofing"] [Division 07 Section on "Cold Fluid-Applied Waterproofing"]** for waterproofing under thickset mortar beds.
2. Division 07 Section on "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
3. Division 09 Section on "Cement Plastering" for scratch coat for thickset mortar setting-bed installations.
4. Division 09 Section on "Gypsum Board" for **[cementitious backer units] [glass-mat, water-resistant backer board]**.

1.2 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For grout and accessories involving color selection.

E. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.**[For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.]**
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 900 mm (36 inches) square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
3. Full-size units of each type of trim and accessory for each color and finish required.
4. Stone thresholds in 150-mm (6-inch) lengths.
5. Metal edge strips in 150-mm (6-inch) lengths.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of product.

C. Product Test Reports: For tile-setting and -grouting products**[and certified porcelain tile]**.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units:**[Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.]**
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Not less than 5 years documented successful experience with work comparable to Work of this Project.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of**[each type of]** floor tile installation.
2. Build mockups of**[each type of]** wall tile installation.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Tile: Obtain **[tile of each type and color or finish] [tile of each type] [tile of each color or finish] [tile]** from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.

1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
2. Obtain **[waterproof membrane] [and] [crack isolation membrane]**, except for sheet products, from manufacturer of setting and grouting materials.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:

1. Stone thresholds.
2. Waterproof membrane.
3. Crack isolation membrane.
4. Cementitious backer units.

5. Metal edge strips.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements**[unless otherwise indicated]**.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation **[in swimming pools] [on exteriors] [or] [in wet areas]**, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS

A. Ceramic Tile Type **[TCB-[##], TCF-[##], or TCW-[##]]**: Factory-mounted **[unglazed] [glazed]** ceramic mosaic tile.

1. Composition: **[Porcelain] [Impervious natural clay or porcelain] [Vitreous or impervious natural clay or porcelain]**.
2. Module Size: [**25.4 by 25.4 mm (1 by 1 inch)**] [**25.4 by 50.8 mm (1 by 2 inches)**] [**50.8 by 50.8 mm (2 by 2 inches)**] <**Insert dimensions**>.
3. Thickness: 6.4 mm (1/4 inch).
4. Face: **[Plain] [Pattern of design indicated,]** with cushion edges.

5. Surface: **[Smooth, without] [Slip resistant, with]** abrasive admixture.
6. Dynamic Coefficient of Friction for Floor Tile: Not less than 0.42.

7. Finish: **[Bright, opaque] [Bright, clear] [Mat, opaque] [Mat, clear] [Semimat, opaque] [Semimat, clear] [Vellum, opaque] [Vellum, clear] [Crystalline] <Insert description>** glaze.
8. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern>**.
9. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.
10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable**[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base Cove: Cove, module size [**25.4 by 25.4 mm (1 by 1 inch)**] [**50.8 by 25.4 mm (2 by 1 inch)**] <**Insert dimensions**>.
    b. Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **[25.4 by 25.4 mm (1 by 1 inch)] [50.8 by 25.4 mm (2 by 1 inch)] <Insert dimensions>**.
    c. Base Cap for Thinset Mortar Installations: Surface bullnose, module size [**25.4 by 25.4 mm (1 by 1 inch)**] [**50.8 by 25.4 mm (2 by 1 inch)**] [**50.8 by 50.8 mm (2 by 2 inches)**] <**Insert dimensions**>.
    d. Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **[25.4 by 25.4 mm (1 by 1 inch)] [50.8 by 25.4 mm (2 by 1 inch)] <Insert dimensions>**.
    e. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size [**25.4 by 25.4 mm (1 by 1 inch)**] [**50.8 by 25.4 mm (2 by 1 inch)**] [**50.8 by 50.8 mm (2 by 2 inches)**] <**Insert dimensions**>.
    f. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
    g. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size **[25.4 by 25.4 mm (1 by 1 inch)] [50.8 by 25.4 mm (2 by 1 inch)] <Insert dimensions>**.
    h. External Corners for Thinset Mortar Installations: Surface bullnose, module size [**25.4 by 25.4 mm (1 by 1 inch)**] [**50.8 by 25.4 mm (2 by 1 inch)**] [**50.8 by 50.8 mm (2 by 2 inches)**] <**Insert dimensions**>.

    i. Internal Corners: Cove, module size [**25.4 by 25.4 mm (1 by 1 inch)**] [**50.8 by 25.4 mm (2 by 1 inch)**] <**Insert dimensions**>.
    j. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

    k. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide

reduction in thickness from 12.7 to 6.4 mm (1/2 to 1/4 inch) across nominal 100-mm (4-inch) dimension.

B. Ceramic Tile Type **[TQB-[##], TQF-[##], or TQW-[##]]**: **[Unglazed] [Glazed]** square-edged quarry tile.

1. Face Size: [**76 by 76 mm (3 by 3 inches)**] [**102 by 102 mm (4 by 4 inches)**] [**152 by 76 mm (6 by 3 inches)**] [**152 by 152 mm (6 by 6 inches)**] [**200 by 98 mm (8 by 3-7/8 inches)**] [**200 by 200 mm (8 by 8 inches)] <Insert dimensions**>.
2. Thickness: **[9.5 mm (3/8 inch)] [12.7 mm (1/2 inch)] [19 mm (3/4 inch)]**.
3. Wearing Surface: **[Nonabrasive, smooth] [Abrasive aggregate embedded in surface] <Insert description**>.
4. Dynamic Coefficient of Friction for Floor Tile: Not less than 0.42.
5. Finish: **[Bright, opaque] [Bright, clear] [Mat, opaque] [Mat, clear] [Semimat, opaque] [Semimat, clear] [Vellum, opaque] [Vellum, clear] [Crystalline] <Insert description**> glaze.
6. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern**>.
7. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color**>.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable**[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:

   a. Base: Coved**[with surface bullnose top edge]**, face size [**152 by 152 mm (6 by 6 inches)**] [**200 by 98 mm (8 by 3-7/8 inches)**] <**Insert dimensions**>.
   b. Wainscot Cap: Surface bullnose, face size [**152 by 152 mm (6 by 6 inches)**] [**200 by 98 mm (8 by 3-7/8 inches)**] <**Insert dimensions**>.
   c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.

C. Ceramic Tile Type **[TCF-[##] or TPF-[##]]**: **[Unglazed] [Glazed]** pressed floor tile.

1. Composition: **[Impervious natural clay or porcelain] [Vitreous or impervious natural clay or porcelain] [Natural clay or porcelain]**.
2. Face Size: **[76 by 76 mm (3 by 3 inches)] [102 by 102 mm (4 by 4 inches)] [152 by 152 mm (6 by 6 inches)] [197 by 98 mm (7-3/4 by 3-7/8 inches)] [200 by 200 mm (7-7/8 by 7-7/8 inches)] [300 by 300 mm (11-13/16 by 11-13/16 inches)] [165 by 333 mm] [200 by 250 mm] [250 by 250 mm] [333 by 333 mm] [400 by 400 mm] <Insert dimensions**>.
3. Face Size Variation: **[Calibrated or rectified] [Rectified]**.
4. Thickness: **[6.4 mm (1/4 inch)**] [**9.5 mm (3/8 inch)**] [**12.7 mm (1/2 inch)**].
5. Face: **[Plain with square or cushion edges] [Plain with square edges] [Plain with cushion edges] [Pattern of design indicated, with square or cushion edges] [As indicated]**.
6. Dynamic Coefficient of Friction: Not less than 0.42.

7. Glaze: **[Bright, opaque] [Bright, clear] [Mat, opaque] [Mat, clear] [Semimat, opaque] [Semimat, clear] [Vellum, opaque] [Vellum, clear] [Crystalline] <Insert description>**.
8. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern>**.
9. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.
10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable**[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base Cove: Cove, module size **[same as adjoining flat tile] <Insert size>**.
    b. Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **[same as adjoining flat tile] <Insert size>**.
    c. Base Cap for Thinset Mortar Installations: Surface bullnose, module size **[same as adjoining flat tile] <Insert size>**.
    d. Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **[same as adjoining flat tile] <Insert size>**.
    e. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size **[same as adjoining flat tile] <Insert size>**.
    f. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
    g. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size **[same as adjoining flat tile] <Insert size>**.
    h. External Corners for Thinset Mortar Installations: Surface bullnose, module size **[same as adjoining flat tile] <Insert size>**.

    i. Internal Corners: Cove, module size **[same as adjoining flat tile] <Insert size>**.
    j. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

    k. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 12.7 to 6.4 mm (1/2 to 1/4 inch) across nominal 100-mm (4-inch) dimension.

D. Ceramic Tile Type **[TPB-[##], TPF-[##], or TPW-[##]]**: **[Unglazed] [Glazed]** porcelain tile.

1. Certification: Tile certified by the Porcelain Tile Certification Agency.
2. Face Size: **[76 by 76 mm (3 by 3 inches)] [102 by 102 mm (4 by 4 inches)] [152 by 152 mm (6 by 6 inches)] [197 by 98 mm (7-3/4 by 3-7/8 inches)] [200 by 200 mm (7-7/8 by**

7-7/8 inches)] [300 by 300 mm (11-13/16 by 11-13/16 inches)] [165 by 333 mm] [200 by 250 mm] [250 by 250 mm] [333 by 333 mm] [400 by 400 mm] <Insert dimensions>.

3. Face Size Variation: Rectified.
4. Thickness: **[6.4 mm (1/4 inch)] [9.5 mm (3/8 inch)] [12.7 mm (1/2 inch)]**.
5. Face: **[Plain with square or cushion edges] [Plain with square edges] [Plain with cushion edges] [Polished with square edges] [As indicated]**.
6. Dynamic Coefficient of Friction for Floor Tile: Not less than 0.42.
7. Tile Color, Glaze, and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color, glaze, and pattern>**.
8. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.
9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable**[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:

   a. Base Cap: Surface bullnose, module size **[same as adjoining flat tile] <Insert size>**.
   b. Wainscot Cap: Surface bullnose, module size **[same as adjoining flat tile] <Insert size>**.
   c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
   d. External Corners: Surface bullnose, module size **[same as adjoining flat tile] <Insert size>**.
   e. Internal Corners: Field-butted square corners.

   f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 12.7 to 6.4 mm (1/2 to 1/4 inch) across nominal 100-mm (4-inch) dimension.

E. Ceramic Tile Type **[TCW-[##]]**: Glazed wall tile.
   1. Module Size: **[108 by 108 mm (4-1/4 by 4-1/4 inches)] [152 by 108 mm (6 by 4-1/4 inches)] [152 by 152 mm (6 by 6 inches)] [200 by 200 mm] [250 by 250 mm] [200 by 300 mm] <Insert dimensions>**.

   2. Face Size Variation: Rectified.
   3. Thickness: 8 mm (5/16 inch).

4. Face: **[Plain with modified square edges or cushion edges] [Plain with modified square edges] [Plain with cushion edges] [Pattern of design indicated, with manufacturer's standard edges]**.
5. Finish: **[Bright, opaque] [Bright, clear] [Mat, opaque] [Mat, clear] [Semimat, opaque] [Semimat, clear] [Vellum, opaque] [Vellum, clear] [Crystalline] <Insert description>** glaze.
6. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern>**.
7. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.
8. Mounting: Factory, back mounted.
9. Mounting: Pregrouted sheets of tiles are factory assembled and grouted with manufacturer's standard white silicone rubber.
10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable**[and matching characteristics of adjoining flat tile]**. Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base for Portland Cement Mortar Installations: Coved, module size **[108 by 108 mm (4-1/4 by 4-1/4 inches)] [152 by 152 mm (6 by 6 inches)] [152 by 95 mm (6 by 3-3/4 inches)] <Insert dimensions>**.
    b. Base for Thinset Mortar Installations: Straight, module size **[108 by 108 mm (4-1/4 by 4-1/4 inches)] [152 by 152 mm (6 by 6 inches)] [152 by 51 mm (6 by 2 inches)] <Insert dimensions>**.
    c. Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap, module size **[108 by 108 mm (4-1/4 by 4-1/4 inches)] [152 by 152 mm (6 by 6 inches)] [152 by 51 mm (6 by 2 inches)] <Insert dimensions>**.
    d. Wainscot Cap for Thinset Mortar Installations: Surface bullnose, module size **[108 by 108 mm (4-1/4 by 4-1/4 inches)] [152 by 152 mm (6 by 6 inches)] [152 by 51 mm (6 by 2 inches)] <Insert dimensions>**.
    e. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
    f. External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at least 19 mm (3/4 inch) unless otherwise indicated.
    g. External Corners for Thinset Mortar Installations: Surface bullnose, same size as adjoining flat tile.
    h. Internal Corners: Field-butted square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

F. Large-Format Glass-Tile Type **[TGW-[##]]**: [Cast] [Fused] [Low temperature].

1. Face Size: [**76 by 76 mm (3 by 3 inches)**] **[102 by 102 mm (4 by 4 inches)] [108 by 108 mm (4-1/4 by 4-1/4 inches)] <Insert dimensions>**.
2. Sizing Category: [**Standard**] [**Natural**].
3. Aesthetic Class: [**V0**] [**V1**] [**V2**] [**V3**] [**V4**].

4. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern>**.
5. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

G. Factory-Mounted Mosaic Glass-Tile Type **[TGW-[##]]**: [**Cast**] [**Fused**] [**Low temperature**].

1. Module Size: [**12.7 by 50.8 mm (1/2 by 2 inches)**] [**12.7 by 76.2 mm (1/2 by 3 inches)**] [**16 by 32 mm (5/8 by 1-1/4 inches)**] [**25.4 by 25.4 mm (1 by 1 inch)**] [**25.4 by 50.8 mm (1 by 2 inches)**] [**50.8 by 50.8 mm (2 by 2 inches)**] [**50.8 by 101.6 mm (2 by 4 inches)**] **<Insert dimensions>**.
2. Sizing Category: [**Standard**] [**Natural**].
3. Aesthetic Class: [**V0**] [**V1**] [**V2**] [**V3**] [**V4**].
4. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern>.**
5. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

H. Factory-Mounted Miniature Mosaic Glass-Tile Type **[TGW-[##]]**: [**Cast**] [**Fused**] [**Low temperature**].

1. Module Size: **[12.7 by 12.7 mm (1/2 by 1/2 inch)] [12.7 by 25.4 mm (1/2 by 1 inch)] [15.9 by 15.9 mm (5/8 by 5/8 inch)] [19 by 19 mm (3/4 by 3/4 inches)] <Insert dimensions>**.
2. Sizing Category: [**Standard**] [**Natural**].
3. Aesthetic Class: [**V0**] [**V1**] [**V2**] [**V3**] [**V4**].
4. Tile Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern>**.
5. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

I. Stone Tile Type **[TSB-[##], TSF-[##], or TSW-[##]]**:

1. Granite: Complying with ASTM C615/C615M.
2. Limestone: Complying with ASTM C568/C568M, Classification [**II (Medium Density)**] [**III (High Density)**].
3. Marble: Complying with ASTM C503/C503M, Classification [**I, Calcite**] [**II, Dolomite**].
4. Quartz-Based Stone: Complying with ASTM C616/C616M, Classification [**II, Quartzitic Sandstone**] [**III, Quartzite**].
5. Serpentine: Complying with ASTM C1526, Classification [**I, Exterior**] [**II, Interior**].
6. Slate: Complying with ASTM C629/C629M, Classification [**I, Exterior**] [**II, Interior**].

7. Travertine: Complying with ASTM C1527/C1527M, Classification [**I, Exterior**] [**II, Interior**].
8. Varieties and Sources:

    a. **<Insert, in separate subparagraphs, name of variety and producer, distributor, or importer>**.

9. Cut: [**Vein**] [**Fleuri**].
10. Finish: **[Polished] [Honed] [Sand rubbed] [Thermal] [Natural cleft] [As indicated] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]**.
11. Edges: **[Square] [Beveled] [Eased]**.
12. Module Size: **[6 by 6 inches (152 by 152 mm)] [6 by 12 inches (152 by 305 mm)] [12 by 12 inches (305 by 305 mm)] [300 by 300 mm] [18 by 18 inches (457 by 457 mm)] [500 by 500 mm] [As indicated]**.
13. Nominal Tile Thickness: **[1/4 inch (6 mm)] [3/8 inch (10 mm)] [1/2 inch (13 mm)] [5/8 inch (16 mm)]**.
14. Joint Width: **[Hand tight] [1/16 inch (1.5 mm)] [1/8 inch (3 mm)] [1/4 inch (6 mm)] [3/8 inch (10 mm)] [1/2 inch (13 mm)]**.
15. Grout Color **[GTG-[##]]**: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

2.4 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

    1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1.5 mm (1/16 inch) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 12.7 mm (1/2 inch) or less above adjacent floor surface.

B. Granite Thresholds **[STG-[##]]**: ASTM C615/C615M, with [**polished**] [**honed**] <**Insert finish**> finish.

    1. Description: Uniform, [**fine**] [**medium**]-grained, [**white**] [**gray**] [**black**] <**Insert color**> stone without veining.
    2. Description: Project Director/COR's sample.
    3. Description: Provide[**one of**] the following:

        a. <**Insert, in separate subparagraphs, name of variety and producer, distributor, or importer**>.

C. Marble Thresholds **[STG-[##]]**: ASTM C 503/C 503M, with a minimum abrasion resistance of **[10] [12]** according to ASTM C 1353 or ASTM C 241/C 241M and with honed finish.

1. Description: Uniform, fine- to medium-grained white stone with gray veining.
2. Description: Match Project Director/COR's sample.
3. Description: Provide**[one of]** the following:

   a. <**Insert, in separate subparagraphs, name of variety and producer, distributor, or importer**>.

2.5 WATERPROOF MEMBRANE

A. General: Manufacturer's standard product**[, selected from the following,]** that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric.

   1. Nominal Thickness: 0.76 mm (0.030 inch).
   2. Nominal Thickness: 1 mm (0.040 inch).

C. PVC Sheet: PVC heat-fused on both sides to facings of nonwoven polyester.

   1. Nominal Thickness: 0.6 mm (0.025 inch).
   2. Nominal Thickness: 1 mm (0.040 inch).

D. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.2-mm (0.008-inch) nominal thickness.

E. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with fabric reinforcement facing; 1 -mm (0.040-inch) nominal thickness.

F. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.

G. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

H. Latex-Portland Cement Waterproof Mortar: Flexible, waterproof mortar consisting of cement-based mix and latex additive.

I. Waterproofing and Tile-Setting Adhesive: One-part, fluid-applied product intended for use as both waterproofing and tile-setting adhesive in a two-step process.

   1. Adhesives shall have a VOC content of **[65]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product**[, selected from the following,]** that complies with ANSI A118.12 for **[standard performance] [high performance]** and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.76-mm (0.030-inch) nominal thickness.

C. PVC Sheet: PVC heat-fused on both sides to facings of nonwoven polyester; 1-mm (0.040-inch) nominal thickness.

D. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.2-mm (0.008-inch) nominal thickness.

E. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 4-mm (3/16-inch) nominal thickness.

F. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, modified-bituminous sheet with fabric reinforcement facing; 1-mm (0.040-inch) nominal thickness.

G. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.

H. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

I. Latex-Portland Cement Crack-Resistant Mortar: Flexible mortar consisting of cement-based mix and latex additive.

J. Crack Isolation Membrane and Tile-Setting Adhesive: One-part, fluid-applied product intended for use as both a crack isolation membrane and tile-setting adhesive in a two-step process.

1. Adhesives shall have a VOC content of **[65]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.7 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

1. Cleavage Membrane: Asphalt felt, ASTM D 226/D 226M, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 0.1 mm (4.0 mils) thick.

2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 50.8 by 50.8 mm (2 by 2 inches) by 1.57-mm (0.062-inch) diameter; comply with ASTM A 185/A 185M and ASTM A 82/A 82M, except for minimum wire size.

3. Latex Additive: **[Manufacturer's standard] [acrylic resin] [or] [styrene-butadiene-rubber]** water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.

1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.

C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with **[acrylic resin] [or] [styrene-butadiene-rubber]** liquid-latex additive at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

D. Medium-Bed, Modified Dry-Set Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of **[16 mm (5/8 inch)]** <**Insert thickness**>.

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with **[acrylic resin] [or] [styrene-butadiene-rubber]** liquid-latex additive at Project site.

E. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.

1. Provide prepackaged, dry-mortar mix containing dr, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with **[acrylic resin] [or] [styrene-butadiene-rubber]** liquid-latex additive at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.15.

F. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thinset): ANSI A118.11.

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. Provide prepackaged, dry-mortar mix combined with **[acrylic resin] [or] [styrene-butadiene-rubber]** liquid-latex additive at Project site.

G. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.

1. Adhesives shall have a VOC content of **[65]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 60 and 100 deg C (140 and 212 deg F), respectively, and certified by manufacturer for intended use.
4. <Type II organic adhesive is also available but is suitable only for interior ceilings and walls subject to dry, light service or limited water exposure.>

H. Organic Adhesive: ANSI A136.1, Type I.

1. Adhesives shall have a VOC content of **[65]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Standard Cement Grout: ANSI A118.6.

C. High-Performance Tile Grout: ANSI A118.7.

1. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
2. Polymer Type: **[Acrylic resin] [or] [styrene-butadiene rubber]** in liquid-latex form for addition to prepackaged dry-grout mix.

D. Water-Cleanable Epoxy Grout: ANSI A118.3

1. **[Grout shall have a VOC content of 65 g/L or less]**.
2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 60 and 100 deg C (140 and 212 deg F), respectively, and certified by manufacturer for intended use.

E. Grout for Pregrouted Tile Sheets: Same product used in factory to pregrout tile sheets.

2.9 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D 4397, 0.1 mm (4.0 mils) thick.

C. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; **[half-hard brass] [white zinc alloy] [nickel silver] [stainless-steel, ASTM A 666, 300 Series]** exposed-edge material. Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile. Approve product prior to use.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

1. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.10 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with **[adhesives] [bonded mortar bed] [or] [thinset mortar]** comply with surface finish requirements in ANSI A108.01 for installations indicated.

a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Project Director/COR.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with **[adhesives] [or] [thinset mortar]** with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1:50 (1/4 inch per foot) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

a. Exterior tile floors.
b. Tile floors in wet areas.
c. Tile swimming pool decks.
d. Tile floors in laundries.
e. Tile floors consisting of tiles 200 by 200 mm (8 by 8 inches) or larger.
f. Tile floors consisting of rib-backed tiles.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Ceramic Mosaic Tile: [**1.6 mm (1/16 inch)**] [**3.2 mm (1/8 inch)**].
2. Quarry Tile: [**6.4 mm (1/4 inch)**] [**9.5 mm (3/8 inch)**].
3. Pressed Floor Tile: [**6.4 mm (1/4 inch)**] [**9.5 mm (3/8 inch)**].
4. Glazed Wall Tile: [**1.6 mm (1/16 inch)**] [**3.2 mm (1/8 inch)**].
5. Porcelain Tile: [**6.4 mm (1/4 inch)**] [**9.5 mm (3/8 inch)**].

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.

1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in **[modified dry-set] [improved modified dry-set]** mortar (thinset).
2. Do not extend **[cleavage membrane] [waterproofing] [or] [crack isolation membrane] under thresholds set in [standard dry-set] [modified dry-set] [or] [improved modified dry-set]** mortar. Fill joints between such thresholds and adjoining tile set on **[cleavage membrane] [waterproofing] [or] [crack isolation membrane]** with elastomeric sealant.

K. Metal Edge Strips: Install **[at locations indicated] [where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile] [where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated]**.

L. Floor Sealer: Apply floor sealer to**[cementitious]** grout joints**[in tile floors]** according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 WATERPROOFING INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.5 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.6 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.7 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.8 EXTERIOR TILE INSTALLATION SCHEDULE

A. Exterior Floor Installations:

1. TCNA F101 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) **[bonded to concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated]**.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.

   b. Bond Coat for Cured-Bed Method: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

2. TCNA F102; thinset mortar [on concrete] **[over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated]**.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

3. TCNA F101 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**: Cement mortar bed (thickset) **[bonded to concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated]**.

   a. Stone Tile Type: **[TSF-[##]]**.

   b. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

4. TCNA F102: Thinset mortar **[on concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated]**.

   a. Stone Tile Type: **[TSF-[##]]**.
   b. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

B. Exterior Roof/Deck Floor Installations:

1. **[TCNA F103] [TCNA F103B]** and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) over drainage material on roof membrane.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.

   b. Bond Coat for Cured-Bed Method: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

2. TCNA F104; thinset mortar **[on concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated].**

   a. Ceramic Tile Type: [**TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** portland cement mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

3. [**TCNA F103**] [**TCNA F103B**] and [**ANSI A108.1A**] [**ANSI A108.1B**] [**ANSI A108.1C**]: Cement mortar bed (thickset) over drainage material on roof membrane.

   a. Stone Tile Type: **[TSF-[##]]**.

   b. Bond Coat for Cured-Bed Method: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

4. TCNA F104: Thinset mortar **[on concrete] [over waterproof membrane on concrete] [over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated]**.

   a. Stone Tile Type: **[TSF-[##]]**.
   b. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

C. Exterior Wall Installations, Masonry or Concrete:

1. TCNA W201 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) on metal lath**[over vapor-retarder membrane]**.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.

   b. Bond Coat for Wet-Set Method: **[Standard] [Modified] [Improved modified]** dry-set mortar.
   c. Bond Coat for Cured-Bed Method: **[Modified dry-set] [Improved modified dry-set]** mortar.
   d. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

2. TCNA W202; thinset mortar**[over waterproof membrane]**.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
   b. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

3. TCNA W201 and **[ANSI A108.14] [ANSI A108.15] [ANSI A108.16]**: Cement mortar bed (thickset) on metal lath**[over vapor-retarder membrane]**.

   a. Glass-Tile Type: **[TGW-[##]]**.
   b. Bond Coat: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

4. TCNA W202: Thinset mortar**[over waterproof membrane]**.

   a. Glass-Tile Type: **[TGW-[##]]**.
   b. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

5. TCNA W201 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**: Cement mortar bed (thickset) on metal lath**[over vapor-retarder membrane]**.

a. Stone Tile Type: **[TSW-[##]]**.

b. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

c. Bond Coat for Cured-Bed Method: **[Dry-set] [Latex-] portland cement mortar.**
d. **Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

6. TCNA W202 STONE: Thinset mortar **[over waterproof membrane]**.

a. Stone Tile Type: **[TSW-[##]]**.
b. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

D. Exterior Wall Installations, Wood or Metal Studs:

1. TCNA W244E; thinset mortar **[over waterproof membrane on cementitious backer units] [on cementitious backer units over vapor-retarder membrane]**.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** portland cement mortar.
c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

2. TCNA W244E: Thinset mortar **[over waterproof membrane on cementitious backer units] [on cementitious backer units over vapor-retarder membrane]**.

a. Stone Tile Type: **[TSW-[##]]**.
b. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

3.9 INTERIOR TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

1. TCNA F111 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) with cleavage membrane.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Stone Tile Type: **[TSF-[##]]**

   c. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set] mortar.**
   d. **Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

2. TCNA F112 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) bonded to concrete.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Stone Tile Type: **[TSF-[##]]**.

   c. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set] mortar.**
   d. **Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

3. TCNA F113; thinset mortar.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Stone Tile Type: **[TSF-[##]]**.
   c. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]**mortar.
   d. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

4. TCNA F114 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) with cleavage membrane; epoxy grout.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.

   b. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]**mortar.
   c. Grout: Water-cleanable epoxy grout.

5. TCNA F115; thinset mortar; epoxy grout.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]**mortar.
   c. Grout: Water-cleanable epoxy grout.

6. TCNA F116; **[organic adhesive] [water-cleanable, tile-setting epoxy]**.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

7. TCNA F121 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) on waterproof membrane.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Stone Tile Type: **[TSF-[##]]**.

   c. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   d. **Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

8. TCNA F122; thinset mortar on waterproof membrane.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Stone Tile Type: **[TSF-[##]]**.
   c. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]**mortar.
   d. Grout: High-performance **[sanded] [unsanded]** grout.

9. **[TCNA F125-Full] [TCNA F125-Full, except where partial coverage is indicated] [TCNA F125-Partial]**; thinset mortar on crack isolation membrane.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Stone Tile Type: **[TSF-[##]]**.
   c. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]**mortar.
   d. Grout: **[Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

10. TCNA F131; water-cleanable, tile-setting epoxy; epoxy grout.

    a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
    b. Grout: Water-cleanable epoxy grout.

11. TCNA F132; water-cleanable, tile-setting epoxy on cured cement mortar bed **[bonded to concrete subfloor] [installed over cleavage membrane]**; epoxy grout.

    a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
    b. Grout: Water-cleanable epoxy grout.

B. Interior Floor Installations, Wood Subfloor:

1. TCNA F121 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) on waterproof membrane.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.

   b. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

2. TCNA F141 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) with cleavage membrane.

   a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
   b. Stone Tile Type: **[TSF-[##]]**.

   c. Bond Coat for Cured-Bed Method**: [Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.

d. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

3. TCNA F142; organic adhesive.

a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
b. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

4. TCNA F143; water-cleanable, tile-setting epoxy; epoxy grout.

a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.
b. Grout: Water-cleanable epoxy grout.

5. TCNA F144; **[thinset mortar] [water-cleanable epoxy adhesive]** on**[waterproof membrane over]** cementitious backer units or fiber-cement backer board.

a. Ceramic Tile Type: **[TCF-[##], TQF-[##], or TPF-[##]]**.

b. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

6. TCNA F250: **[Thinset mortar] [Water-cleanable, tile-setting epoxy]** on**[waterproof membrane over]** cementitious backer units or fiber-cement backer board.

a. Stone Tile Type: **[TSF-[##]].**

b. Thinset Mortar: **[Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

C. Interior Wall Installations, Masonry or Concrete:

1. TCNA W202; thinset mortar.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass Tile Type: **[TGW-[##]].**

c. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Medium-bed, modified dry-set] [Improved modified dry-set]** mortar.
d. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

2. TCNA W211 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) bonded to substrate.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.

d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

e. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

3. TCNA W221 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**, cement mortar bed (thickset) on metal lath **[over cleavage membrane] [over waterproof membrane]**.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.
d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

e. Bond Coat for Cured-Bed Method**: [Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

4. TCNA W222 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; one-coat cement mortar bed (thickset) on metal lath **[over cleavage membrane] [over waterproof membrane].**

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
   b. Glass Tile Type: **[TGW-[##]]**.
   c. Stone Tile Type: **[TSW-[##]]**.

   d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

   e. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
   f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

5. TCNA W223: Organic adhesive.

   a. Glass-Tile Type: **[TGW-[##]]**.
   b. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

D. Interior Wall Installations, Metal Studs or Furring:

1. TCNA W221 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) **[over cleavage membrane] [over waterproof membrane]** on solid backing.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
   b. Glass-Tile Type: **[TGW-[##]]**.
   c. Stone Tile Type: **[TSW-[##]]**.

   d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

   e. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

2. TCNA W222 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; one-coat cement mortar bed (thickset) **[over cleavage membrane] [over waterproof membrane]** on solid backing.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
   b. Glass-Tile Type: **[TGW-[##]]**.
   c. Stone Tile Type: **[TSW-[##]]**.

   d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

   e. Bond Coat for Cured-Bed Method**: [Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
   f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

3. TCNA W223; organic adhesive on solid backing.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
   b. Glass-Tile Type: **[TGW-[##]]**.
   c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

   d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

   e. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
   f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

4. TCNA W242; organic adhesive on gypsum board.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.

b. Glass-Tile Type: **[TGW-[##]]**.
c. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

5. TCNA W243; thinset mortar on gypsum board.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.
d. Thinset Mortar**: [Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

6. TCNA W244C or TCNA W244F; thinset mortar on cementitious backer units or fiber-cement backer board**[over vapor-retarder membrane]**.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
d. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

7. TCNA W245 or TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.
d. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

E. Bathtub Wall Installations with No Shower Head, Wood or Metal Studs or Furring:

1. TCNA B413; **[thinset mortar] [organic adhesive]** on water-resistant gypsum board.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.

d. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

F. Bathtub/Shower Wall Installations, Wood or Metal Studs or Furring:

1. TCNA B411 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) over vapor-retarder membrane.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.

d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

e. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

2. TCNA B412; **[thinset mortar] [organic adhesive] [water-cleanable, tile-setting epoxy]** on cementitious backer units or fiber-cement backer board.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.

d. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

3. TCNA B419; thinset mortar on coated glass-mat, water-resistant gypsum backer board.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.
d. Thinset Mortar: **[Modified dry-set] [Improved modified dry-set]** mortar.

e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

G. Shower Receptor and Wall Installations:

1. TCNA B414 and **[ANSI A108.1A] [ANSI A108.1B] [ANSI A108.1C]**; cement mortar bed (thickset) over vapor-retarder membrane.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
   b. Glass-Tile Type: **[TGW-[##]]**.
   c. Stone Tile Type: **[TSW-[##]]**.

   d. Bond Coat for Wet-Set Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.

   e. Bond Coat for Cured-Bed Method: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
   f. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

2. TCNA B415; **[thinset mortar] [organic adhesive] [water-cleanable, tile-setting epoxy]** on **[waterproof membrane over cementitious backer units or fiber-cement backer board] [cementitious backer units or fiber-cement backer board over vapor-retarder membrane]**.

   a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
   b. Glass-Tile Type: **[TGW-[##]]**.
   c. Stone Tile Type: **[TSW-[##]]**.

   d. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
   e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

3. TCNA B420; thinset mortar on **[waterproof membrane over coated glass-mat, water-resistant gypsum backer board] [coated glass-mat, water-resistant gypsum backer board over vapor-retarder membrane]**.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.
d. Thinset Mortar: **[Modified dry-set] [Improved modified dry-set]** mortar.
e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded] [Water-cleanable epoxy]** grout.

4. TCNA B421; thinset mortar on waterproof membrane over solid backing.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.
d. Thinset Mortar: **[Modified dry-set] [Improved modified dry-set] mortar.**
e. **Grout: [Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

5. TCNA B422; thinset mortar on waterproof membrane with integrated bonding flange for bonded membranes.

a. Ceramic Tile Type: **[TCW-[##], TQW-[##], or TPW-[##]]**.
b. Glass-Tile Type: **[TGW-[##]]**.
c. Stone Tile Type: **[TSW-[##]]**.
d. Thinset Mortar: **[Standard dry-set] [Modified dry-set] [Improved modified dry-set]** mortar.
e. Grout: **[Sand-portland cement] [Standard sanded cement] [Standard unsanded cement] [High-performance sanded] [High-performance unsanded]** grout.

END OF SECTION 093013

SECTION 095113- ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

B. Material Index / Material Codes Include:

1. **APC-[##] <ACOUSTICAL PANEL CEILING.>**

C. Related Requirements:

1. **[Division 09 Section on "Linear Metal Ceilings."]**

D. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Laboratory Test Reports: For ceiling products, indicating compliance with requirements for low-emitting materials.

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of **[full-size] [150-mm- square]** <**Insert size**> Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of **[150-mm-]** <**Insert dimension**> long Samples of each type, finish, and color.
3. Clips: Full-size **[hold-down] [impact] [and] [seismic]** clips.

D. Delegated-Design Submittal: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

a. Lighting fixtures.
b. Diffusers.
c. Grilles.
d. Speakers.
e. Sprinklers.
f. Access panels.
g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Interface With Other Systems: Coordinate layout and installation of acoustical ceiling units, suspension system components and accessories with other Work supported by, or penetrating through, ceilings. This includes, but is not limited to: light fixtures, fire and smoke detection system components, HVAC equipment, fire-suppression system components and partition system.
9. Minimum Drawing Scale: **[1:48] [1:96] [1:50] [1:100]** <**Insert scale**>.

B. Product Test Reports: For each acoustical panel ceiling, include tests performed by **[manufacturer and witnessed by a qualified testing agency] [a qualified testing agency]**.

C. Evaluation Reports: For each acoustical panel ceiling suspension system**[and anchor and fastener type]**, include evaluation from ICC-ES.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials**[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
3. Hold-Down Clips: Equal to 2 percent of quantity installed.
4. Impact Clips: Equal to 2 percent of quantity installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Not less than 5 years documented successful experience with work comparable to Work of this Project.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical ceiling area as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR, based on input from the A/E of Record, specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Ceiling products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Delegated Design: Engage a qualified professional engineer to design seismic restraints for ceiling systems.

C. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and OBO-ICS Building Code requirements.

D. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 50 or less.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

2.4 ACOUSTICAL PANELS **[APC-[##] - APC-[##]]**:

A. Product **[APC-[##]]**:

1. Classification:

   a. Type and Form: <**Insert Type**>
   b. Pattern: <**Insert Pattern**>

2. Color: **[White] [As selected from manufacturer's full range] [Match Project Director/COR's sample based on input from the A/E of Record] [As indicated by manufacturer's designation] [As indicated on Drawings] [As indicated in a schedule] <Insert color>**.
3. Light Reflectance (LR): Not less than 0.80.
4. Ceiling Attenuation Class (CAC): Not less than **[CAC indicated in a schedule] [20] [25] [30] [35] [40] <Insert CAC>**.
5. Noise Reduction Coefficient (NRC): Not less than 0.75.
6. Articulation Class (AC): Not less than **[AC indicated in a schedule] [170] [180] [190] [200] [210] <Insert AC>**.
7. Edge/Joint Detail: **[Square] [Reveal sized to fit flange of exposed suspension-system members] [Flush reveal sized to fit flange of exposed suspension-system members] [Beveled, kerfed, and rabbeted long edges and square, butt-on short edges] [As indicated by manufacturer's designation] <Insert requirement>**.

8. Thickness: **[15 mm] [19 mm] [22 mm] [As indicated on Drawings] [As indicated in a schedule] <Insert thickness>**.

9. Thickness: **[3 mm] [12 mm] [15 mm] [15 mm] [19 mm] [22 mm] [25 mm] [38 mm] [51 mm] [76 mm] [As indicated on Drawings] [As indicated in a schedule] <Insert dimension>**.

10. Modular Size: **[610 by 610 mm] [610 by 1220 mm] [610 by 1830 mm] [610 by 2440 mm] [1220 by 1220 mm] [600 by 600 mm] [600 by 1200 mm] [As indicated on Drawings] [As indicated in a schedule] <Insert size>**.
11. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D.

2.5 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.

1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C 635/C 635M.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25]** <**Insert value**> percent.

2.6 METAL SUSPENSION SYSTEMS:

A. Product:

1. Wide-Face, Capped, Double-Web,**[Fire-Rated,]** Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, Z90 coating designation; with prefinished 24-mm- wide metal caps on flanges.

a. Structural Classification: **[Intermediate] [Heavy]**-duty system.
b. End Condition of Cross Runners: **[Override (stepped)] [or] [butt-edge]** type.
c. Face Design: Flat, flush.
d. Cap Material: **[Cold-rolled steel] [or] [aluminum]**.
e. Cap Finish: **[Painted white] [Painted in color as selected from manufacturer's full range] [Painted to match color indicated by manufacturer's designation] [Painted to match color of acoustical unit] [Plated with metallic finish as selected from manufacturer's full range] [Plated with metallic finish indicated by manufacturer's designation] [Natural finish for aluminum]**.

B. Product:

1. Narrow-Face, Capped, Double-Web,**[Fire-Rated,]** Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, Z90 coating designation; with prefinished 15-mm- wide metal caps on flanges.

    a. Structural Classification: **[Intermediate] [Heavy]**-duty system.
    b. End Condition of Cross Runners: **[Override (stepped)] [or] [butt-edge]** type.
    c. Face Design: **[Flat, flush] [Flanges formed with an integral center reveal]**.
    d. Cap Material: **[Cold-rolled steel] [or] [aluminum]**.
    e. Cap Finish: **[Painted white] [Painted in color as selected from manufacturer's full range] [Painted to match color indicated by manufacturer's designation] [Painted to match color of acoustical unit] [Plated with metallic finish as selected from manufacturer's full range] [Plated with metallic finish indicated by manufacturer's designation] [Natural finish for aluminum]**.

2.7 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

    a. Type: **[Cast-in-place] [Postinstalled expansion] [Postinstalled bonded]** anchors.

    b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B 633, Class SC 1 (mild) service condition.
    c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316.
    d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than **[2.69-mm-] [3.5-mm-]** <**Insert dimension**> diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 22 mm wide; formed with 1-mm- thick, galvanized-steel sheet complying with ASTM A 653/A 653M, Z275 coating designation; with bolted connections and 8-mm- diameter bolts.

F. Hold-Down Clips: Manufacturer's standard hold-down.

G. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

I. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

2.8 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
2. For lay-in panels with reveal edge details, provide **[stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member]** <**Insert description**>.

3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.

1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 0.04 mm. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.9 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Division 07 Section on "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C 636/C 636M**[, seismic design requirements,]** and manufacturer's written instructions.

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required **[and, if permitted with fire-resistance-rated ceilings,]** to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. **[Do not attach hangers to steel deck tabs.]**
9. **[Do not attach hangers to steel roof deck. Attach hangers to structural members.]**
10. Space hangers not more than 1200 mm o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 200 mm from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without

attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 400 mm o.c. and not more than 75 mm from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned acoustical panels as follows:

a. As indicated on reflected ceiling plans.
b. Install panels with pattern running in one direction parallel to **[long] [short]** axis of space.
c. Install panels in a basket-weave pattern.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.

5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install **[hold-down] [impact] [and] [seismic]** clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.

a. Hold-Down Clips: Space **[610 mm]** <**Insert dimension**> o.c. on all cross runners.

7. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 3 mm in 3.6 m, non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 3 mm in 3.6 m, non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Government will engage a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

B. Testing Agency: Government will engage a qualified testing agency to perform tests and inspections.

C. **[Testing and inspections will be performed of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.]**

1. [Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 900 N of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 1950 N of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.]

D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 095423 - LINEAR METAL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes strip, linear metal pans and suspension systems for ceilings.

B. Material Index / Material Codes Include:

1. **MTC-[##] <(LINEAR) METAL CEILING.>**

C. Related Requirements:

1. Division 09 Section on "Acoustical Metal Pan Ceilings" for clip-in, lay-in, snap-in, and torsion-spring-hinged metal pan ceilings with exposed suspension systems.

1.2 DEFINITIONS

A. LR: Light Reflectance coefficient.

B. NRC: Noise Reduction Coefficient.

1.3 COORDINATION

A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:

1. Linear Metal Pan: Set of 300-mm- (12-inch-) long Samples of each type and color and a 300-mm- (12-inch-) long spliced section.
2. Suspension System Members: 300-mm- (12-inch-) long Sample of each type.
3. Exposed Molding and Trim: Set of 300-mm- (12-inch-) long Samples of each type, finish, and color.
4. Filler Strips: Set of 300-mm- (12-inch-) long Samples of each type, finish, and color.
5. Sound Absorber: 300 mm (12 inches) long.
6. End Cap: Full size.

D. Delegated-Design Submittal: For design of **[seismic restraints and]**attachment devices.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Linear pattern.
2. Joint pattern.
3. Ceiling suspension members.
4. Method of attaching hangers to building structure.

a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

5. Ceiling-mounted items including, but not limited to, light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
6. Ceiling perimeter and penetrations through ceiling; trim and moldings.
7. Minimum Drawing Scale: **[1:48 (1/4 inch = 1 foot)] [1:96 (1/8 inch = 1 foot)] [1:50] [1:100]** <**Insert scale**>.

B. Product Test Reports: For each linear metal ceiling, for tests performed by a qualified testing agency.

C. Evaluation Reports: For linear metal ceiling and components**[and anchor and fastener type]**.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Linear Metal Ceiling Components: Quantity of each pan, carrier, accessory, and exposed molding and trim equal to 2 percent of quantity installed.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by National Voluntary Laboratory Accreditation Program for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver ceiling components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle ceiling components, and accessories carefully to avoid damaging units and finishes in any way.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not install linear metal ceilings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design **[seismic restraints and]**attachment devices.

B. Structural Performance: Exterior linear metal ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling pans; or permanent damage to fasteners and anchors:

1. Wind Load: Uniform pressure **[of 960 Pa (20 lbf/sq. ft.)] [of 1436 Pa (30 lbf/sq. ft.)] [as indicated on Drawings]** <**Insert pressure**>, acting inward or outward.
2. Seismic Criteria: Provide linear metal ceilings designed and installed to withstand the effects of earthquake motions according to the following:

a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580/E 580M.
b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2."
c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4."
d. ASCE/SEI 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 67 deg C (120 deg F), ambient; 100 deg C (180 deg F) material surfaces.

D. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25]** <**Insert value**> percent.

E. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 LINEAR METAL CEILING PANS **[MTC-[##]]**:

A. Acoustical Metal Pan Standard: Provide manufacturer's standard linear metal pans of configuration indicated that comply with ASTM E 1264 classifications as designated by types, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 400 mm (15-3/4 inches) away from test surface per ASTM E 795.

B. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.

1. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209M (ASTM B 209); alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
2. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C 635/C 635M.

a. Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A 879/A 879M, 12G (04Z) coating; surface treatment as recommended by finish manufacturer for type of use and finish indicated.

b. Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A 1008/A 1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.

3. Stainless-Steel Sheet: Complying with ASTM A 240/A 240M, **[Type 304] [Type 430]**.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated to snap on and be securely retained on carriers without separate fasteners, and finished to comply with requirements indicated.

D. Pan Splices: Construction same as pans, in lengths 200 to 300 mm (8 to 12 inches); with manufacturer's standard finish.

E. End Caps: **[Metal matching pans] [Plastic] [Manufacturer's standard material]**; fabricated to fit and conceal exposed ends of pans.

F. Filler Strips: **[Metal matching pans] [Plastic] [Manufacturer's standard material]**; fabricated to uninterruptedly close voids between pans.

G. Moldings and Trim: Provide manufacturer's standard moldings and trim for exposed members, and as indicated or required, for edges and penetrations of ceiling, around fixtures, at changes in ceiling height, and for other conditions; of same metal and finish as linear metal ceiling pans.

H. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.

1. Bond fabric layer to pan in the factory with manufacturer's standard nonflammable adhesive.

I. Sound-Absorbent Pads: Provide width and length to completely fill between carriers, joined at center of panel, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84, and to comply with the following requirements:

1. Plastic Sheet-Wrapped Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C 553, Type I, II, or III, and as follows:

a. Mineral-Fiber Type and Thickness: Glass fiber; **[25 mm (1 inch)] [38 mm (1-1/2 inches)] [76 mm (3 inches)] <Insert dimension>**.
b. Mineral-Fiber Density: [**12 kg/cu. m (3/4 lb/cu. ft.)**] [**16 kg/cu. m (1 lb/cu. ft.)**] [**24 kg/cu. m (1-1/2 lb/cu. ft.)**] **<Insert value>**.
c. Plastic Sheet Thickness and Color: Not less than 0.076 mm (0.003 inch); **[clear] [flat black] [white] <Insert requirements>**.

2. Unwrapped, Glass-Fiber Insulation: Black-coated, unfaced, glass-fiber insulation complying with ASTM C 553, Type I, II, or III, not less than 16-kg/cu. m (1-lb/cu. ft.) density, treated to be nondusting, and as follows:

a. Thickness: [**25 mm (1 inch)**] [**38 mm (1-1/2 inches)**] **<Insert dimension>**.

2.3 METAL SUSPENSION SYSTEMS

A. Metal Suspension Systems Standard: Provide ceiling manufacturer's standard metal suspension systems of types and finishes indicated that comply with applicable ASTM C 635/C 635M requirements.

B. Suspension Systems: Provide systems complete with carriers, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, Direct Hung, unless otherwise indicated.

1. Cast-in-Place and Postinstalled Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to **[five] <Insert safety factor>** times that imposed by ceiling construction, as determined by testing per ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: **[Cast-in-place] [Postinstalled expansion] [Postinstalled bonded]** anchors.

b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.

d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

D. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

2. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635/C 635M, Table 1, Direct Hung is less than yield stress of wire, but provide not less than 2.69-mm- (0.106-inch-) diameter wire.

E. Carriers: Factory finished **[with matte-black baked finish]** <Insert finish description>.

1. Main Carriers: Aluminum, not less than 6.0-mm (0.240-inch) rolled sheet, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, complying with ASTM B 209M (ASTM B 209).
2. Main Carriers: Steel, not less than 0.53-mm (0.0209-inch) nominal thickness, cold-rolled sheet, with factory-applied protective coating, complying with ASTM C 635/C 635M.

a. Electrolytic Zinc-Coated Steel: ASTM A 879/A 879M, not less than **[24G (08Z)]** <**Insert coating designation**> zinc coating.
b. Hot-Dip Galvanized Steel: ASTM A 653/A 653M, not less than **[Z180 (G60)]** <**Insert coating designation**> zinc coating.

3. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.

4. Flexible Radial Carriers: Manufacturer's standard radial carriers.

5. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.

F. Carrier Splices: Same metal, profile, and finish as for carriers.

G. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers at regular intervals and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated; and factory finished with matte-black baked finish.

H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

I. Exterior Bracing: Cold-rolled steel channels and angles, hot-dip galvanized to comply with ASTM A 653/A 653M, Z180 (G60) coating designation; size and profile as required to withstand wind load.

J. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.

K. Edge Moldings and Trim: Provide exposed members as indicated or required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.

1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.4 ALUMINUM PANS AND SUSPENSION SYSTEM FOR LINEAR METAL CEILING **[MTC-[##]]**:

A. Aluminum Pans and Suspension System:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers**

offering products that may be incorporated into the Work include, but are not limited to, the following]:

2. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>** or comparable product by one of the following:

   a. American Decorative Ceilings (ADC).
   b. Ceilings Plus.
   c. Chicago Metallic Corporation.
   d. Hunter Douglas Architectural Products, Inc.
   e. Simplex Ceilings, a division of Intalite Inc.
   f. United States Gypsum Company.

B. Classification: Units complying with ASTM E 1264 for **[Type XIII, aluminum strips with mineral- or glass-fiber-base backing; Form 1, perforated] [Type XIII, aluminum strips with mineral- or glass-fiber-base backing; Form 2, unperforated] [Type XX, other types described as perforated aluminum strips with sound-absorbent fabric backing] <Insert Type XX description>**.

   1. Pattern: **<Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, and percent open area>**.

C. Pan Thickness: Not less than [**0.46 mm (0.018 inch)**] [**0.56 mm (0.022 inch)**] [**0.6 mm (0.024 inch)**] [**0.65 mm (0.025 inch)**] [**0.7 mm (0.027 inch)**] [**0.8 mm (0.032 inch)**] [**1.0 mm (0.040 inch)**] **<Insert dimension>**.

D. Pan Edge Detail: **[Beveled] [Square] [Round] [Manufacturer's standard edge detail]**.

E. Linear Module Width and Pan Face Width: **[51-mm (2-inch) module width and 32-mm (1-1/4-inch) face width] [102-mm (4-inch) module width and 83-mm (3-1/4-inch) face width] [152-mm (6-inch) module width and 133-mm (5-1/4-inch) face width] [203-mm (8-inch) module width and 184-mm (7-1/4-inch) face width] [100-mm module width and 80-mm face width] [200-mm module width and 180-mm face width] [300-mm module width and 280-mm face width] [As indicated on Drawings] <Insert dimensions>**.

F. Pan Depth: **[16 mm (5/8 inch) deep] [19 mm (3/4 inch) deep] [Not less than 25 to 38 mm (1 to 1-1/2 inches) deep] [15 mm deep] [As indicated] <Insert depth>**.

G. Pan Face Finish: **[Mill] [Lacquered mill] [Clear anodized] [Clear mirror-anodized] [Painted white] [Painted to match color indicated by product designation] [Painted to match Project Director/COR's sample based on input from the A/E of Record] [Painted in color selected from manufacturer's full range] [High-performance organic coating in color selected from manufacturer's full range] [Bright-reflective finish selected from manufacturer's full range] <Insert finish>**.

H. End Cap, Finish of Exposed Portions: **[Matte black] [To match pan] [Manufacturer's standard finish]**.

I. Filler Strip Design: **[Recessed] [Flush] [An integral extension of pan profile] [Expansion, for use with expansion carriers] [Slotted, for air diffusion]**.

J. Filler Strip, Finish of Exposed Portions: **[Matte black] [To match pan]**.

K. LR: Not less than **[0.70] [0.75]** <**Insert LR**>.

L. NRC: Not less than **[0.65] [0.75] [0.95]** <**Insert NRC**>.

M. Suspension-System Main-Carrier Material: **[Aluminum] [Electrolytic zinc-coated steel] [Hot-dip galvanized steel] [Manufacturer's standard material and protective finish]**.

2.5 STEEL PANS AND SUSPENSION SYSTEM FOR LINEAR METAL CEILING **[MTC-[##]]**:

A. Steel Pans and Suspension System:

1. Manufacturers: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]**:
2. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings]** <**Insert manufacturer's name; product name or designation**> or comparable product by one of the following:

   a. Ceilings Plus.
   b. Chicago Metallic Corporation.
   c. Hunter Douglas Architectural Products, Inc.
   d. United States Gypsum Company.

B. Classification: Units complying with ASTM E 1264 for **[Type XIII, steel strips with mineral- or glass-fiber-base backing; Form 1, perforated] [Type XIII, steel strips with mineral- or glass-fiber-base backing; Form 2, unperforated] [Type XX, other types described as perforated steel strips with sound-absorbent fabric backing]** <**Insert Type XX description**>.

1. Pattern: <**Insert pattern designation for perforated pans and any requirements for perforation alignment, hole shape and size, holes per square foot or inch, and percent open area**>.

C. Pan Thickness: Not less than [**0.4 mm (0.015 inch)**] [**0.5 mm (0.020 inch)**] [**0.6 mm (0.024 inch)**] [**0.75 mm (0.030 inch)**] <**Insert dimension**>.

D. Pan Edge Detail: **[Beveled] [Square] [Round] [Manufacturer's standard edge detail]**.

E. Linear Module Width and Pan Face Width: **[51-mm (2-inch) module width and 32-mm (1-1/4-inch) face width] [102-mm (4-inch) module width and 83-mm (3-1/4-inch) face width] [152-mm (6-inch) module width and 133-mm (5-1/4-inch) face width] [203-mm (8-inch) module width and 184-mm (7-1/4-inch) face width] [As indicated on Drawings] <Insert dimensions>**.

F. Pan Depth: **[16 mm (5/8 inch) deep] [19 mm (3/4 inch) deep] [Not less than 25 to 38 mm (1 to 1-1/2 inches) deep] [15 mm deep] [As indicated] <Insert depth>**.

G. Pan Face Finish: **[Painted white] [Painted to match color indicated by product designation] [Painted to match Project Director/COR's sample based on input from the A/E of Record] [Painted in color selected from manufacturer's full range] [Electroplated finish selected from manufacturer's full range] <Insert finish>**.

H. End Cap, Finish of Exposed Portions: **[Matte black] [To match pan] [Manufacturer's standard finish]**.

I. Filler Strip Design: **[Recessed] [Flush] [An integral extension of pan profile] [Expansion, for use with expansion carriers] [Slotted, for air diffusion]**.

J. Filler Strip, Finish of Exposed Portions: **[Matte black] [To match pan]**.

K. LR: Not less than **[0.70] [0.75] <Insert LR>**.

L. NRC: Not less than **[0.65] [0.75] [0.95] <Insert NRC>**.

M. Suspension-System Main-Carrier Material: **[Aluminum] [Electrolytic zinc-coated steel] [Hot-dip galvanized steel] [Manufacturer's standard material and protective finish]**.

2.6 ACCESSORIES

A. Access Panels: For access at locations indicated, provide door hinge assembly, retainer clip, and retainer bar, assembled with ceiling panels and carrier sections into access doors of required size, permitting upward or downward opening.

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

2.8 ALUMINUM FINISHES

A. Mill Finish: AA-M10C10.

B. Lacquered Mill Finish: AA-M10C10R1x with manufacturer's standard clear, organic coating.

C. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

D. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.

E. Color-Coated Finish: Manufacturer's standard**[powder-coat]** baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with **[AAMA 2604] [AAMA 2605]** and containing not less than **[50] [70]** percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

G. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical, bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

2.9 GALVANIZED-STEEL SHEET FINISHES

A. Color-Coated Finish: Manufacturer's standard**[powder-coat]** baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

2.10 STEEL SHEET FINISHES

A. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.

B. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical, bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of linear metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and on Coordination Drawings.

3.3 INSTALLATION

A. Comply with ASTM C 636/C 636M and seismic requirement indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws,

or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.

5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.

9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 1200 mm (48 inches) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 200 mm (8 inches) from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers but without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.

1. Screw attach moldings to substrate at intervals not more than 400 mm (16 inches) o.c. and not more than 75 mm (3 inches) from ends, leveling with ceiling suspension system to a tolerance of 3.2 mm in 3.6 m (1/8 inch in 12 feet). Miter corners accurately and connect securely.

2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.

G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.

1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
3. Install pans with butt joints using internal pan splices and in the following joint configuration:

   a. Aligned.
   b. Aligned, every other pan length.
   c. Staggered a minimum of 300 mm (12 inches).
   d. Random.
   e. As indicated.

4. Install directionally textured metal pans in directions indicated.
5. Where metal pan ends are visible, install end caps unless trim is indicated.

6. Install filler strips where indicated.

7. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.

H. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: **[Project Director/COR will engage] [Engage]** a qualified special inspector to perform the following special inspections:

1. Suspended ceiling system.
2. Hangers, anchors, and fasteners.

B. Testing Agency: **[Project Director/COR will engage] [Engage]** a qualified testing agency to perform tests and inspections.

C. Tests and Inspections: Testing and inspecting of completed installations of linear metal ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of linear metal ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Test Areas: Test installation of ceiling suspension systems on each floor when installation has reached 20 percent completion but before pans have been installed.

a. Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 890 N (200 lbf) of tension; it will also select 1 of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 1957 N (440 lbf) of tension.
b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Linear metal ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 095423

SECTION 096340 - STONE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimension stone exterior flooring.
2. Dimension stone interior flooring.
3. Dimension stone stair treads **[and risers]**.
4. Dimension stone thresholds.

B. Material Index / Material Codes Include:

1. STF-[##] <STONE FLOORING OR PAVING.>
2. STG-[##] <STONE STAIR TREADS.>
3. STG-[##] <STONE THRESHOLDS.>

C. Related Requirements:

1. Division 04 Section on “Exterior Stone Cladding” for exterior stone.
2. Division 07 Section on "Joint Sealants" for sealing joints in stone flooring system with elastomeric sealants.
3. Division 09 Section on “Stone Wall Facing”.
4. Division 32 Section on "Unit Paving" for stone pavers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each **[variety of stone,]** stone accessory, and manufactured product.

B. Sustainable Design Submittals:

1. Product Certificates: For materials manufactured within 100 miles (160 km) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

4. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, sections, details, and attachments to other work.

1. Show locations and details of joints both within stone flooring and between stone flooring and other finish materials.
2. Show direction of veining, grain, or other directional patterns.

D. Samples for Verification:

1. For each stone type indicated, in sets of Samples not less than 300 mm (12 inches) square. Include at least **[two] [three] [four] [five]** <**Insert number**> or more Samples in each set and show the full range of color and other visual characteristics in completed Work.
2. For each color of **[grout] [pointing mortar]** required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Material Test Reports:

1. Stone Test Reports: For**[each]** stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, according to referenced ASTM standards. Base reports on testing within previous **[three] [five]** <**Insert number**> years.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stone flooring to include in maintenance manuals. Include product data for stone-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate stone flooring.

B. Installer Qualifications: A firm or individual experienced in installing stone flooring similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance. Not less than 5 years documented successful experience with work comparable to Work of this Project.

C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.

1. Build mockups of typical interior floor area **[as shown on Drawings] [about 2400 mm (96 inches) square] <Insert size>**.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

B. Mark stone units, on surface that is concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels, so that they are right side up when units are installed.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.8 FIELD CONDITIONS

A. Maintain air and material temperatures to comply with requirements of installation material manufacturers, but not less than 10 deg C (50 deg F) during installation and for seven days after completion.

B. Cold-Weather Requirements for Exterior Stone Flooring: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

C. Hot-Weather Requirements for Stone Flooring: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. Maintain temperature of materials below 38 deg C (100 deg F).
2. Do not apply mortar to substrates with temperatures of 38 deg C (100 deg F) and above.
3. When the ambient temperature exceeds 32 deg C (90 deg F), fog spray installed stone flooring until damp at least three times a day until flooring is three days old.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Stone: Obtain **[each variety of]** stone, **[regardless of finish,]**from single quarry**[, whether specified in this Section or in another Section of the Specifications,]** with resources to provide materials of consistent quality in appearance and physical properties.

1. For stone types that include same list of varieties and sources, provide same variety from same source for each.

2. Make stone slabs available for examination by Project Director/COR.

a. Project Director/COR will select**, based on input from the A/E of Record,** aesthetically acceptable slabs[and will indicate aesthetically unacceptable portions of slabs].
b. Segregate slabs selected for use on Project and mark backs indicating approval.
c. Mark and photograph aesthetically unacceptable portions of slabs as directed by Project Director/COR.

3. Physical Properties:

a. Slip Resistance: Provide a DCOF rating of 0.42 or better.

2.2 GRANITE **[STF-[##] OR STG-[##]]**

A. Material Standard: Comply with ASTM C 615/C 615M.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: Uniform, **[fine] [medium]-grained, [white] [pink] [gray] [black] <Insert color> stone[without veining]**.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

E. Cut: **[Vein] [Fleuri]**.

F. Minimum Thickness: Comply with ASTM C1528.

G. Finish: **[Polished] [Honed] [Thermal] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.3 LIMESTONE **[STF-[##] OR STG-[##]]**

A. Material Standard: Comply with ASTM C 568/C 568M.

1. Classification: **[II Medium] [III High]** Density.

2. Stone Abrasion Resistance: Minimum value of **[10]** <**Insert value**>, based on testing according to ASTM C 241/C 241M or ASTM C 1353.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: **[Dolomitic] [Oolitic] [Shell]** limestone.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

E. Cut: **[Vein] [Fleuri]**.

F. Minimum Thickness: Comply with ASTM C1528.

G. Finish: **[Smooth finish] [Sand rubbed] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**> **[, matching standard ILI finish]**.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.4 MARBLE **[STF-[##] OR STG-[##]]**

A. Material Standard: Comply with ASTM C 503/C 503M**[, Classification I Calcite] [, Classification II Dolomite] [, Group A] [, Group B] [, Group C] [, Group D]**.

1. Stone Abrasion Resistance: Minimum value of **[10]** <**Insert value**>, based on testing according to ASTM C 241/C 241M or ASTM C 1353.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: Uniform, fine- to medium-grained, **[white]** <**Insert color**> stone with only slight veining.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

E. Cut: **[Vein] [Fleuri]**.

F. Minimum Thickness: Comply with ASTM C1528.

G. Finish: **[Polished] [Honed] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.5 QUARTZ-BASED STONE **[STF-[##] OR STG-[##]]**

A. Material Standard: Comply with ASTM C 616/C 616M, Classification III Quartzite.

1. Stone Abrasion Resistance: Minimum value of **[10]** <**Insert value**>, based on testing according to ASTM C 241/C 241M or ASTM C 1353.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Minimum Thickness: Comply with ASTM C1528.

E. Finish: **[Sand rubbed] [Natural cleft] [Thermal] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

F. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.6 SERPENTINE **[STF-[##] OR STG-[##]]**

A. Material Standard: Comply with ASTM C 1526, Classification II Interior.

1. Stone Abrasion Resistance: Minimum value of **[10]** <**Insert value**>, based on testing according to ASTM C 241/C 241M or ASTM C 1353.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Minimum Thickness: Comply with ASTM C1528.

E. Finish: **[Polished] [Honed] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

F. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.7 SLATE **[STF-[##] OR STG-[##]]**

A. Material Standard: Comply with ASTM C 629/C 629M, Classification II Interior.

1. Stone Abrasion Resistance: Minimum value of **[8]** <**Insert value**>, based on testing according to ASTM C 241/C 241M or ASTM C 1353.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: **[Black] [Blue-black] [Gray] [Blue-gray] [Green] [Purple] [Mottled purple and green] [Red]** slate with a fine, even grain**[and unfading color,]** from clear, sound stock.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

E. Minimum Thickness: Comply with ASTM C1528.

F. Finish: **[Honed] [Sand rubbed] [Natural cleft] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

G. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.8 TRAVERTINE **[STF-[##] OR STG-[##]]**

A. Material Standard: Comply with ASTM C 1527/C 1527M, Classification II Interior.

1. Stone Abrasion Resistance: Minimum value of **[10]** <**Insert value**>, based on testing according to ASTM C 241/C 241M or ASTM C 1353

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Cut: Vein.

E. Filling: Fill pores on faces of stone with cementitious filler of color **[selected by Project Director/COR] [matching Project Director/COR's sample]**.

F. Minimum Thickness: Comply with ASTM C1528.

G. Finish: **[Polished] [Honed] [As indicated] [Match Project Director/COR's sample] <Insert finish>**.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.9 OTHER STONE **[STF-[##] OR STG-[##]]**

A. Material Standards:

1. Maximum Absorption according to ASTM C 97/C 97M: <**Insert required value**>.
2. Minimum Compressive Strength according to ASTM C 170/C 170M: <**Insert required value**>.
3. Minimum Flexural Strength according to ASTM C 880/C 880M: <**Insert required value**>.
4. Minimum Modulus of Rupture according to ASTM C 99/C 99M: <**Insert required value**>.

5. Stone Abrasion Resistance: Minimum value of **[10] [12] <Insert value>**, based on testing according to ASTM C 241/C 241M or ASTM C 1353.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Minimum Thickness: Comply with ASTM C1528.

E. Finish: **[Polished] [Honed] [Sand rubbed] [Natural cleft] [As indicated] [Match Project Director/COR's sample] <Insert finish>**.

F. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.10 MORTAR MATERIALS

A. **[Regional Materials: Aggregate for mortar and grout[, cement, and lime] shall be manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.]**

B. Portland Cement: ASTM C 150/C 150M, Type I or Type II**.[Provide natural color or white cement as required to produce mortar color indicated.]**

1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

C. Hydrated Lime: ASTM C 207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150/C 150M, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in stone masonry mortar.

F. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix shall produce color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments shall not exceed 10 percent of portland cement by weight.

G. Aggregate: ASTM C 144; except for **[joints narrower than 6 mm (1/4 inch)] [and] [pointing mortar]**, use aggregate graded with 100 percent passing 1.18-mm (No. 16) sieve.

1. White Aggregates: Natural white sand or ground white stone.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.

H. Latex Additive: **[Manufacturer's standard] [acrylic-resin] [or] [styrene-butadiene-rubber]** water emulsion, serving as replacement for part of or all gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.

I. Thinset Mortar:

1. Standard Dry-Set Mortar: ANSI A118.1.
2. Modified Dry-Set Mortar: ANSI A118.4.

   a. Prepackaged Dry-Mortar Mix: Factory-prepared, packaged mixture of portland cement; dry, redispersible, ethylene vinyl acetate or acrylic additive; and other ingredients to which only water needs to be added at Project site.
   b. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of packaged dry-mortar mix and **[styrene-butadiene-rubber] [or] [acrylic-resin]** liquid-latex additive.

3. Medium-Bed Modified Dry-Set Mortar: ANSI A118.4. Provide product that is approved by manufacturer for application thickness of **[16 mm (5/8 inch)]** <**Insert value**>.

   a. Prepackaged Dry-Mortar Mix: Factory-prepared, packaged mixture of portland cement; dry, redispersible, ethylene vinyl acetate or acrylic additive; and other ingredients to which only water needs to be added at Project site.
   b. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of packaged dry-mortar mix and **[styrene-butadiene-rubber] [or] [acrylic-resin]** liquid-latex additive.

4. Improved Modified Dry-Set Mortar: ANSI A118.15.

   a. Prepackaged Dry-Mortar Mix: Factory-prepared, packaged mixture of portland cement; dry, redispersible, ethylene vinyl acetate or acrylic additive; and other ingredients to which only water needs to be added at Project site.
   b. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of packaged dry-mortar mix and **[styrene-butadiene-rubber] [or] [acrylic-resin]** liquid-latex additive.

J. Water: Potable.

2.11 GROUT

A. Grout Colors: **[Match stone] [As indicated by manufacturer's designations] [Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]**.

B. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate to produce required color.

C. Standard Cement Grout: ANSI A118.6, packaged.

1. Unsanded grout mixture for joints 3 mm (1/8 inch) and narrower.
2. Sanded grout mixture for joints wider than 3 mm (1/8 inch).

D. High-Performance Cement Grout: ANSI A118.7, packaged.

1. Polymer Type: **[Acrylic resin] [or] [ethylene vinyl acetate]**, in dry, redispersible form, packaged with other dry ingredients.
2. Polymer Type: **[Acrylic resin] [or] [styrene-butadiene rubber]** in liquid-latex form for addition to packaged dry-grout mix.

3. Unsanded grout mix for joints 3 mm (1/8 inch) and narrower.
4. Sanded grout mix for joints wider than 3 mm (1/8 inch).

E. Water-Cleanable Epoxy Grout: ANSI A118.3 packaged, chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.

2.12 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product**[, selected from the following,]** that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.76-mm (0.030-inch) nominal thickness.

C. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 1.01-mm (0.040-inch) nominal thickness.

2.13 ACCESSORIES

A. Water-Cleanable Epoxy Adhesive: ANSI A118.3.

1. Adhesives shall have a VOC content of **[65]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Cleavage Membrane: Polyethylene sheeting, ASTM D 4397, 0.1 mm (4.0 mils) thick**[; or unperforated asphalt felt, ASTM D 226/D 226M, Type I (No. 15)]**.

C. Reinforcing Wire: Galvanized, welded, 1.57-mm- (0.062-inch-) diameter wire; 50-by-50-mm (2-by-2-inch) mesh; comply with ASTM A 1064/A 1064M, except for minimum wire size.

D. Divider Strips and Edging: Metal or combination of metal and PVC or neoprene base, designed specifically for flooring applications, in longest lengths available, and as follows:

1. Exposed-Edge Material: **[Half-hard brass] [White zinc alloy] [Nickel silver] [Stainless steel; ASTM A 666, Type 302]**.
2. Cross-Section Profile: **[Angle or L-shape] [T-shape, single or two part] [Straight shape]**.
3. Height**: [Match stone thickness] [Equal to stone thickness plus depth of setting bed]**.
4. Exposed-Edge Width: **[1.6 mm (0.063 inch)] [3.2 mm (1/8 inch)] [6.4 mm (1/4 inch)] [10 mm (3/8 inch)]**.
5. Control-Joint Filler: Neoprene.

E. Abrasive Inserts for Stair Treads: Abrasive strips consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder, fabricated for installing in routed grooves of stair treads to provide slip resistance. Provide epoxy-resin installation adhesive compatible with inserts.

1. Width: [**6.4 mm (1/4 inch)**] <**Insert dimension**>.
2. Depth: [**12.7 mm (1/2 inch)**] <**Insert dimension**>.
3. Length: **[100 mm (4 inches) less than stair width] [As indicated]**.

F. Joint Sealants: Manufacturer's standard sealants that comply with applicable requirements in Division 07 Section on "Joint Sealants" and will not stain the stone they are applied to.

1. Use mildew-resistant joint sealant at plumbing fixtures and for control and expansion joints in toilet rooms**[and other wet locations]**.
2. Colors: Provide colors of exposed sealants to match other joints in stone adjoining sealed joints unless otherwise indicated.

G. Cleaner: Stone cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer**[and by sealer manufacturer]**. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

H. Floor Sealer: Colorless, slip- and stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

1. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.14 MORTAR **[AND GROUT]**MIXES

A. Mortar: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

1. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated. Do not use calcium chloride.
2. Combine mortar materials and thoroughly mix in a mechanical batch mixer unless otherwise indicated. Discard mortar when it has reached initial set.

3. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding any water. Add only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Portland Cement-Lime Setting Mortar: ASTM C 270, Proportion Specification, **[Type N] [Type S]**. Use amount of water to produce a stiff mixture with a moist surface when bed is ready to receive stone.

C. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions and to produce a stiff mixture with a moist surface when bed is ready to receive stone.

D. Mortar-Bed Bond Coat: Mix neat cement and **[water] [latex additive]** to a creamy consistency.

E. Cement-Paste Bond Coat: Mix either neat cement or cement and sand with water to a consistency similar to that of thick cream.

F. Latex-Modified Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.

G. Pointing Mortar: Comply with requirements indicated above for setting mortar, including type and the following:

1. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
2. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
3. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.

H. Joint Grout: Comply with mixing requirements in referenced ANSI standards and with manufacturer's written instructions.

2.15 STONE FABRICATION

A. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.

1. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by Project Director/COR.

B. Fabricate stone to comply with requirements indicated and with the following references:

1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

3. For marble, comply with recommendations in MIA's "Dimension Stone - Design Manual VII."
4. For stone not otherwise indicated, comply with recommendations in MIA's "Dimension Stone - Design Manual VII."

C. Cut stone to produce pieces of thickness, size, and shape indicated.

1. Stone Thickness: [**13 mm (1/2 inch)**] [**20 mm (3/4 inch)**] [**21 mm (7/8 inch)**] [**25 mm (1 inch)**] [**32 mm (1-1/4 inches)**] [**50 mm (2 inches)**] unless otherwise indicated.
2. Pattern: **[Rectangular] [Diamond]-grid pattern of [305 by 305 mm (12 by 12 inches)] [457 by 457 mm (18 by 18 inches)] [610 by 610 mm (24 by 24 inches)]**.
3. Pattern: Rectilinear **[brickwork] [herringbone]** pattern of 305-by-610-mm (12-by-24-inch) units.
4. Pattern: Random, rectangular pattern composed of units of not less than **[152 mm (6 inches)] [203 mm (8 inches)] or more than [610 mm (24 inches)] [813 mm (32 inches)]** in nominal dimension.
5. Pattern: Random, polygonal pattern composed of units of not less than 0.09 sq. m (1 sq. ft.) or more than 0.46 sq. m (5 sq. ft.) in area.
6. Pattern: As indicated.
7. Stone Edges: **[Square cut with top corner slightly eased to prevent snipping] [Square cut with 1.5-mm- (1/16-inch-) wide bevel at top corner] [Rough split] [As indicated].**
8. **Joint Width: [1.5 mm (1/16 inch)] [3 mm (1/8 inch)] [6 mm (1/4 inch)] [10 mm (3/8 inch)]** <**Insert dimension**>.

D. Pattern Arrangement: Fabricate and arrange stone units with veining and other natural markings to comply with the following requirements:

1. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
2. Arrange units **[with veining as indicated on Drawings] [in blend pattern]**.
3. Book match adjacent units**[in each row and between adjacent rows]**.
4. Book match adjacent units in each row, and arrange units in end-slip pattern between adjacent rows.
5. Arrange units in side-slip**[and end-slip]** pattern.
6. Arrange four units adjoining center point of room in two-way book match, and arrange surrounding units in side-slip and end-slip pattern.
7. Number stone units and note numbers on Shop Drawings to designate installation location of each unit.

E. Fabricate stone thresholds in sizes and profiles as indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges of thresholds at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 13 mm (1/2 inch) or less, and finish bevel to match adjacent surfaces of threshold.
2. Where difference in floor levels exceeds 13 mm (1/2 inch), bevel edge of threshold at 1:12 slope, aligning lower edge of bevel with adjacent floor finish. Finish bevel to match adjacent surfaces of threshold.

F. Fabricate stone stair treads in sizes and profiles indicated**.[Rout grooves into treads to receive abrasive strips and install strips to comply with manufacturer's written instructions.][Cut grooves about 3 mm (1/8 inch) wide by 1.5 mm (1/16 inch) deep in stair treads as indicated.]**

G. Carefully inspect finished stone units at fabrication plant for compliance with appearance, material, and fabrication requirements. Replace defective units. Clean sawed backs of stones to remove rust stains and iron particles.

1. Grade and select stone for overall uniform appearance when assembled in place.
2. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved Samples**[and sample installations]**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive stone flooring and conditions under which stone flooring will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone flooring.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone flooring.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. **[Vacuum] [Sweep]** concrete substrates to remove dirt, dust, debris, and loose particles.

B. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

C. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1:50 (1/4 inch per foot) toward drains.

D. Before setting stone, clean dirty or stained stone surfaces by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION, GENERAL

A. Do necessary field cutting as stone is set. Cut lines straight and true, and finish field-cut edges to match shop-cut edges.

1. Use power saws with diamond blades to cut stone**[, except for stone that is specified to have rough-split edges]**.

B. Set stone to comply with requirements indicated.**[Match stone for color and pattern by using units numbered in sequence as indicated on Shop Drawings.]**

C. Scribe and field cut stone as necessary to fit at obstructions. Produce neat joints of size specified or indicated.

D. Provide control and expansion joints of widths and at locations indicated. Keep control and expansion joints free of mortar, grout, and other rigid materials.

3.4 INSTALLATION TOLERANCES

A. Variation in Line: For positions shown in plan for edges of flooring, ramps, steps, changes in color or finish, and continuous joint lines, do not exceed 3 mm in 3 m (1/8 inch in 10 feet), 6 mm in 6 m (1/4 inch in 20 feet), or 10 mm (3/8 inch) maximum.

B. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1.5 mm (1/16 inch) or one-fourth of nominal joint width, whichever is less.

C. Variation in Surface Plane: Do not exceed 3 mm in 3 m (1/8 inch in 10 feet), 6 mm in 6 m (1/4 inch in 20 feet), or 10 mm (3/8 inch) maximum from level or slope indicated.

D. Variation in Plane between Adjacent Units (Lipping): Do not exceed 0.8-mm (1/32-inch) difference between planes of adjacent units.

3.5 INSTALLATION OF STONE BONDED TO CONCRETE

A. Saturate concrete with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat to damp concrete and broom to provide an even coating that completely covers the concrete. Do not exceed 1.5-mm (1/16-inch) thickness. Limit area of mortar-bed bond coat to avoid its drying out before placing setting bed.

1. Place reinforcing wire mesh over concrete, lapped at joints by at least one full mesh and supported so mesh becomes embedded in middle of mortar bed. Hold edges back from vertical surfaces about 13 mm (1/2 inch).

C. Apply mortar bed immediately after applying mortar-bed bond coat. Spread, tamp, and screed to uniform thickness at elevations required for setting stone to finished elevations indicated.

D. Mix and place only that amount of mortar bed that can be covered with stone before initial set. Cut back, bevel edge, and discard material that has reached initial set before stone can be placed.

E. Place stone before initial set of mortar occurs. Immediately before placing stone on setting bed, apply uniform 1.5-mm- (1/16-inch-) thick bond coat to mortar bed or to back of each stone unit.

F. Tamp and beat stone with a wooden block or rubber mallet to obtain full contact with mortar bed and to bring finished surfaces within indicated tolerances. Set each unit in a single operation before initial set of mortar; do not return to areas already set and disturb stone for purposes of realigning finished surfaces or adjusting joints.

G. Rake out joints to depth required to receive **[grout] [pointing mortar]** as units are set.

H. Point joints after setting. Fill full with mortar type and color indicated. Tool joints flat, uniform, and smooth, without visible voids.

3.6 INSTALLATION OF STONE OVER **[CLEAVAGE MEMBRANE] [WATERPROOFING]**

A. Place cleavage membrane over substrates indicated to receive stone, lapped at least 100 mm (4 inches) at joints.

B. See waterproofing Section for installation of waterproofing**[and protection board]**.

1. Carefully place stone and setting materials over waterproofing, so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with stone flooring.
2. Provide cork joint filler, where indicated, at waterproofing that is turned up on vertical surfaces or, if not indicated, provide temporary filler or protection until stone flooring installation is complete.

C. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

1. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

D. Place reinforcing wire fabric over **[cleavage membrane] [waterproofing] [protection board]**, lapped at least one full mesh at joints and supported so mesh becomes embedded in middle of mortar bed. Hold edges back from vertical surfaces and control and expansion joints about 13 mm (1/2 inch).

E. Place mortar bed over **[cleavage membrane] [waterproofing] [protection board]** with reinforcing wire fabric fully embedded in middle of mortar bed. Spread, tamp, and screed to uniform thickness at elevations required for setting stone to finished elevations indicated.

F. Mix and place only that amount of mortar bed that can be covered with stone before initial set. Cut back, bevel edge, and discard material that has reached initial set before stone can be placed.

G. Place stone before initial set of mortar occurs. Immediately before placing stone on setting bed, apply uniform 1.5-mm- (1/16-inch-) thick bond coat to mortar bed or to back of each stone unit.

H. Tamp and beat stone with a wooden block or rubber mallet to obtain full contact with mortar bed and to bring finished surfaces within indicated tolerances. Set each unit in a single operation before initial set of mortar; do not return to areas already set and disturb stone for purposes of realigning finished surfaces or adjusting joints.

I. Rake out joints to depth required to receive **[grout] [pointing mortar]** as units are set.

J. Point joints after setting. Fill full with mortar type and color indicated. Tool joints flat, uniform, and smooth, without visible voids.

3.7 INSTALLATION OF STONE FLOORING ON PEDESTALS OVER WATERPROOFING

A. See waterproofing Section for installation of waterproofing**[and protection board]**.

B. Accurately install pedestals and other accessories to elevations required. Adjust for final level and slope with shims.

1. Fill pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.

C. Loosely lay stone flooring units on pedestals, maintaining a uniform, open joint width. Tightly seat stone units against spacers to eliminate lateral movement or drift of flooring assembly. Align joint patterns parallel in each direction.

1. Lay out stone units to avoid less than half-width units at perimeter or other terminations.

D. Install stone flooring units to not vary more than 1.5 mm (1/16 inch) in elevation between adjacent units.

3.8 STONE THRESHOLD INSTALLATION

A. At locations adjacent to stone flooring, install stone thresholds in same type of setting bed as abutting stone flooring unless otherwise indicated.

1. Set thresholds in thinset mortar to comply with ANSI A108.5 at locations where mortar bed would otherwise be exposed above other adjacent flooring.

B. At locations not adjacent to stone flooring, install stone thresholds in **[thinset mortar to comply with ANSI A108.5] [water-cleanable epoxy adhesive to comply with ANSI A108.4]**.

3.9 STONE STAIR TREAD**[AND RISER]** INSTALLATION

A. Install stone stair treads **[and risers]**to comply with "Installation of Stone Bonded to Concrete" Article.

B. Install stone stair treads **[and risers]**in **[thinset mortar to comply with ANSI A108.5] [water-cleanable epoxy adhesive to comply with ANSI A108.4]**.

3.10 GROUTING

A. Grout stone joints to comply with ANSI A108.10 and with manufacturer's written instructions.

1. Do not use sanded grout for polished stone.
2. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining stone and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free of drying cracks.

B. Grout stone joints with water-cleanable epoxy grout to comply with ANSI A108.6 and with manufacturer's written instructions.

3.11 JOINT-SEALANT INSTALLATION

A. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Division 07 Section on "Joint Sealants."

3.12 ADJUSTING AND CLEANING

A. Remove and replace stonework of the following description:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Project Director/COR.
2. Defective joints.
3. Stone flooring and joints not matching approved Samples and sample installations.
4. Stonework not complying with other requirements indicated.

B. Replace in a manner that results in stonework matching approved Samples and sample installations, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean stonework as work progresses. Remove **[mortar fins and smears] [grout smears]** before tooling joints.

D. Clean stonework after setting and **[pointing] [grouting]** are complete. Use procedures recommended by stone fabricator for application types.

E. Apply sealer to cleaned stonework according to sealer manufacturer's written instructions.

3.13 PROTECTION

A. Prohibit traffic from installed stone for a minimum of 72 hours.

B. Protect installed stonework during construction with nonstaining kraft paper. Where adjoining areas require construction work access, cover stonework with a minimum of 20-mm (3/4-inch) untreated plywood over nonstaining kraft paper.

END OF SECTION 096340

SECTION 096400 - WOOD FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Factory-finished wood flooring.
2. Field-finished wood flooring.
3. Sound control underlayment.

B. Material Index / Material Codes Include:

1. WDF-[##] <WOOD FLOORING.>

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
2. Credit EQ 4.1: For adhesives and sealants used inside the weatherproofing system, include printed statement of VOC content.
3. Credit EQ 4.2: For field-applied paints and coatings used inside the weatherproofing system, include printed statement of VOC content.
4. Credit EQ 4.3: For hard surface flooring systems, include documentation from an independent testing agency indicating compliance with the FloorScore Standard. For flooring system finishes, include printed statement of VOC content.

C. Shop Drawings: For each type of floor assembly and accessory. Include plans, sections, and attachment details. Include expansion provisions and trim details.

D. Samples: For each exposed product and accessory, and for each color and texture specified, approximately 300 mm (12 inches) long and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data:

1. Submit manufacturer's written maintenance instructions which describe materials, devices and procedures to be followed in cleaning and maintaining flooring.
2. Include manufacturer's brochures describing actual materials, finishes and accessories used in Work.
3. Include copy of maintenance instructions in Project maintenance and information manual.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wood Flooring: Equal to 1 percent of amount installed for each type, color, and finish of wood flooring indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Not less than 5 years documented, successful experience with work comparable to Work of this Project.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood flooring materials in unopened cartons or bundles.

B. Protect wood flooring from exposure to moisture. Do not deliver wood flooring until after concrete, masonry, plaster, ceramic tile, and similar wet-work is complete and dry.

C. Store wood flooring materials in a dry, warm, ventilated, weathertight location.

1.7 FIELD CONDITIONS

A. Conditioning period begins not less than seven days before wood flooring installation, is continuous through installation, and continues not less than seven days after wood flooring installation.

1. Environmental Conditioning: Maintain ambient temperature between 18 and 24 deg C (65 and 75 deg F) and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.

2. Wood Flooring Conditioning: Move wood flooring into spaces where it will be installed, no later than the beginning of the conditioning period.

   a. Do not install flooring until it adjusts to relative humidity of, and is at same temperature as, space where it is to be installed.
   b. Open sealed packages to allow wood flooring to acclimatize immediately on moving flooring into spaces in which it will be installed.

B. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

C. Install factory-finished wood flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hardwood Flooring: Comply with NWFA A500 for species, grade, and cut.

B. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

2.2 FIELD-FINISHED WOOD FLOORING

A. Solid-Wood Flooring **[WDF-[##]]**: Kiln dried to 6 to 9 percent maximum moisture content; tongue and groove and end matched; with backs channeled.

1. Grade and Species: **[Clear red oak] [Select red oak] [No. 1 Common red oak] [No. 2 Common red oak] [MFMA-RL First Grade hard maple] [MFMA-RL Second and Better Grade hard maple] [Grade C & BTR - Flooring Douglas fir] [Grade D - Flooring Douglas fir] <Insert grade and species>**.
2. Cut: **[Plain sawn] [Quarter/rift sawn] [Edge grain] [Vertical grain] <Insert description>.**
3. Thickness: **[20 mm (25/32 inch)] [19 mm (3/4 inch)] <Insert dimension>.**
4. Face Width: **[57 mm (2-1/4 inches)] [79 mm (3-1/8 inches)] [130 mm (5-1/8 inches)] <Insert dimension>.**
5. Lengths: **[Manufacturer's standard] [Random-length strips complying with applicable grading rules] [Lengths required to form pattern indicated] <Insert requirements>**.

B. Solid-Wood Parquet Flooring: Kiln dried to 6 to 9 percent maximum moisture content.

1. Species: **[Red oak] [White oak] [Ash] [Maple] [Black cherry] <Insert species>.**
2. Grade: **<Insert grade>.**
3. Thickness: **[8 mm (5/16 inch)] [17 mm (11/16 inch)] [6 mm (1/4 inch)] <Insert dimension>**.
4. Pattern: **<Insert description>.**
5. Size: **<Insert dimension>.**

C. Engineered-Wood Flooring **[WDF-[##]]**: HPVA EF[**, complying with requirements for composite wood products**].

1. Species: **[Red oak] [White oak] [Ash] [Beech] [Maple] [Black cherry] <Insert species>**.
2. Grade: **<Insert grade>**.
3. Thickness: **[13 mm (1/2 inch)] [10 mm (3/8 inch)] <Insert dimension>**.
4. Construction: **[Five] [Three]** ply.
5. Face Width: **[57 mm (2-1/4 inches)] [76 mm (3 inches)] <Insert dimension>**.
6. Length: Manufacturer's standard.

D. Urethane Finish System: Complete [**solvent-based, oil-modified**] [**water-based**] system of compatible components that is recommended by finish manufacturer for application indicated.

1. Stain: Penetrating and nonfading type.

   a. Color: **[Match sample] [As selected by Architect from manufacturer's full range] <Insert color>**.

2. Floor Sealer: Pliable, penetrating type.
3. Finish Coats: Formulated for multicoat application on wood flooring.

E. Wood Filler: Compatible with finish system components and recommended by filler and finish manufacturers for use indicated. If required to match approved Samples, provide pigmented filler.

2.3 FACTORY-FINISHED WOOD FLOORING

A. Solid-Wood Flooring **[WDF-[##]]**: Kiln dried to 6 to 9 percent maximum moisture content; tongue and groove and end matched; with backs channeled.

1. Species: **[Red oak] [White oak] [Ash] [Birch] [Maple] [Black cherry] [Hickory] [Walnut] <Insert species>**.
2. Grade: **<Insert grade>**.

3. Cut: **[Plain sawn] [Quarter/rift sawn] [Edge grain] [Vertical grain] <Insert description>**.
4. Thickness: **[19 mm (3/4 inch)] [20 mm (25/32 inch)] <Insert dimension>**.
5. Face Width: **[57 mm (2-1/4 inches)] [79 mm (3-1/8 inches)] [130 mm (5-1/8 inches)] <Insert dimension>**.
6. Lengths: **[Random-length strips complying with applicable grading rules] [Lengths required to form pattern indicated] <Insert requirements>**.
7. Edge Style: **[Square] [Beveled (eased)] <Insert style>**.
8. Finish: UV urethane.

    a. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]** <**Insert color**>.

B. Solid-Wood Parquet Flooring **[WDF-[##]]**: Kiln dried to 6 to 9 percent maximum moisture content.

1. Species: **[Red oak] <Insert species>**.
2. Grade: **<Insert grade>**.
3. Thickness: **[8 mm (5/16 inch)] [17 mm (11/16 inch)] [6 mm (1/4 inch)] <Insert dimension>**.
4. Edge Style: **<Insert style>**.
5. Pattern: **<Insert description>**.
6. Size: **<Insert dimension>**.
7. Finish: **[UV urethane] [Acrylic impregnated]**.

    a. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]** <**Insert color**>.

C. Engineered-Wood Flooring **[WDF-[##]]**: HPVA EF[**, complying with requirements for composite wood products**].

1. Species: **[Red oak] [White oak] [Ash] [Beech] [Birch] [Maple] [Black cherry] [Hickory] [Walnut] <Insert species>**.
2. Grade: **<Insert grade>**.
3. Thickness: **[13 mm (1/2 inch)] [10 mm (3/8 inch)] <Insert dimension>**.
4. Construction: **[Five] [Three]** ply.
5. Face Width: **[57 mm (2-1/4 inches)] [76 mm (3 inches)] <Insert dimension>**.
6. Length: Manufacturer's standard.
7. Edge Style: **[Square] [Beveled (eased)] <Insert style>**.
8. Finish: **[UV urethane] [Acrylic impregnated]**.

a. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]** <**Insert color**>.

D. Engineered-Wood Parquet Flooring **[WDF-[##]]**: HPVA EF[**, complying with requirements for composite wood products**].

1. Species: **[Red oak] [Ash] [Beech] [Maple] [Walnut] <Insert species>**.
2. Grade: **<Insert grade>**.
3. Thickness: **[10 mm (3/8 inch)] [13 mm (1/2 inch)] <Insert dimension>**.
4. Construction: **[Five] [Three]** ply.
5. Edge Style: **<Insert style>**.
6. Pattern: **<Insert description>**.
7. Size: **<Insert dimension>**.
8. Finish: UV urethane.

a. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]** <**Insert color**>.

2.4 SOUND CONTROL UNDERLAYMENT

A. Sound Control Underlayment: Sound reducing underlayment consisting of impact-absorbing materials. Minimum Impact Insulation Class (IIC) of [**50**] [**55**] <**Insert value**> when tested according to ASTM E492.

1. Material: **[Recycled rubber] [Polyurethane foam] [Wood fiber] [Wood fiber complying with requirements for composite wood products] <Insert material>**.
2. Thickness: [**19 mm (3/4 inch)**] [**13 mm (1/2 inch)**] [**10 mm (3/8 inch)**] [**6 mm (1/4 inch)**] [**4 mm (5/32 inch)**] **<Insert dimension>**.

2.5 ACCESSORY MATERIALS

A. Wood Sleepers and Subfloor: [**As specified in Division 06 Section on "Rough Carpentry" and Division 06 Section on "Sheathing."**] <**Insert requirements.**>

B. Wood Underlayment: [**As specified in Division 06 Section on "Sheathing."**] <**Insert requirements.**>

C. Vapor Retarder: ASTM D4397, polyethylene sheet not less than [**6.0 mils (0.15 mm)**] [**8.0 mils (0.2 mm)**] thick.

D. Asphalt-Saturated Felt: ASTM D4869/D4869M, Type II.

E. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.

F. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood flooring manufacturer.

G. Fasteners: As recommended by manufacturer, but not less than that recommended in [**NWFA's "Installation Guidelines."**] <**Insert standard or publication.**>

H. Thresholds and Saddles: To match wood flooring. Tapered on each side.

I. Reducer Strips: To match wood flooring. [**51 mm (2 inches)**] <**Insert dimension**> wide, tapered, and in thickness required to match height of flooring.

J. Cork Expansion Strip: Fine-grained composition cork strip, color: **[natural cork][stained color to compliment wood flooring finish] <Insert color>**.

K. Feature Strips: [**2-inch- (51-mm-) wide, square-edged walnut strips**] <**Insert description**>, furnished in lengths as long as practical and in thickness to match wood flooring.

L. Metal Feature Strips: [**1/8-by-1/8-inch (3-by-3-mm) solid-brass strips**] <**Insert description**>, designed for inlaying into routed reveal in wood flooring surface.

M. Wood Air Vents and Grilles: To match wood flooring and in sizes and design indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Concrete Slabs: Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

1. Moisture Testing: Perform tests so that each test area does not exceed 304.8 sq. m (1000 sq. ft.), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **[1.36 kg of water/92.9 sq. m (3 lb of water/1000 sq. ft.)]** in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
c. Perform additional moisture tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

3.2 PREPARATION

A. Concrete Slabs:

1. Grind high spots and fill low spots to produce a maximum 1/8-inch (3-mm) deviation in any direction when checked with a 10-foot (3-m) straight edge.
2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

3. Remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

B. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in [**NWFA's "Installation Guidelines."**] <**Insert standard or publication.**>

B. Wood Sleepers and Subfloor: [**Install according to requirements in Division 06 Section on "Rough Carpentry" and Division 06 Section on "Sheathing."**] <**Insert requirements.**>

C. Wood Underlayment: [**Install according to requirements in Division 06 Section on "Sheathing."**] <**Insert requirements.**>

D. Provide expansion space at walls and other obstructions and terminations of flooring **of not less than 19 mm (3/4 inch)**.

E. Vapor Retarder: Comply with the following for vapor retarder installation:

1. Wood Flooring Nailed to Wood Subfloor: Install flooring over a layer of asphalt-saturated felt.
2. Wood Flooring Nailed to Sleepers over Concrete: Install flooring over a layer of polyethylene sheet with edges overlapped over sleepers and turned up behind baseboards.
3. Wood Flooring Installed Directly on Concrete: Install a layer of polyethylene sheet according to flooring manufacturer's written instructions.

F. Sound Control Underlayment: Install over vapor retarder according to manufacturer's written instructions.

G. Solid-Wood Flooring: Blind nail or staple flooring to substrate.

H. Solid-Wood Parquet Flooring: Set in adhesive in pattern indicated on Drawings.

I. Engineered-Wood Flooring: [**Set in adhesive**] [**Nail or staple**] [**Install floating floor**].

3.4 FIELD FINISHING

A. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that are noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.

1. Comply with applicable recommendations in [**NWFA's "Installation Guidelines."**] <**Insert standard or publication.**>

B. Fill [**open-grained hardwood**] <**Insert description of wood to be filled**>.

C. Fill and repair wood flooring defects.

D. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated, but not less than one coat of floor sealer and [**three**] <**Insert number**> finish coats.

1. Apply stains to achieve an even color distribution matching approved Samples.
2. For water-based finishes, use finishing methods recommended by finish manufacturer to minimize grain raise.

E. Cover wood flooring before finishing.

F. Do not cover wood flooring after finishing until finish reaches full cure, and not before seven days after applying last finish coat.

3.5 PROTECTION

A. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.

1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 096400

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoset-rubber base.
2. Thermoplastic-rubber base.
3. Rubber stair accessories.
4. Rubber molding accessories.

B. Material Index / Material Codes Include:

1. RLB-[##] <RESILIENT MATERIAL (THERMOSET-RUBBER) BASE.>
2. RLB-[##] <RESILIENT MATERIAL (THERMOPLASTIC-RUBBER) BASE.>
3. RLG-[##] <RESILIENT MATERIAL (RUBBER) STAIR ACCESSORIES.>
4. RLG-[##] <RESILIENT MATERIAL (RUBBER) MOLDING ACCESSORIES.>

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For sealants, indicating VOC content.
4. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For resilient base and stair products and accessories, indicating compliance with requirements for low-emitting materials.
6. Environmental Product Declaration: For each product.
7. Health Product Declaration: For each product.
8. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

C. Samples: For each exposed product and for each color and texture specified, not less than 300 mm (12 inches) long.

D. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials**[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 3 linear m (10 linear feet) for every 150 linear m (500 linear feet) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Coordinate mockups in this Section with sample installations specified in other Sections.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 10 deg C (50 deg F) or more than 32 deg C (90 deg F).

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 21 deg C (70 deg F) or more than 35 deg C (95 deg F), in spaces to receive resilient products during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 13 deg C (55 deg F) or more than 35 deg C (95 deg F).

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 THERMOSET-RUBBER BASE **[RLB-[##]]**

A. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

1. Style and Location:

a. Style A, Straight: Provide in areas with carpet.
b. Style B, Cove: Provide in areas with hard surface floor coverings.

B. Thickness: 3.2 mm (0.125 inch).

C. Height: **[102 mm(4 inches)] [As indicated on Drawings]**.

D. Lengths: Coils in manufacturer's standard length.

E. Outside Corners: **[Job formed] [Preformed] [Job formed or preformed]**.

F. Inside Corners: **[Job formed] [Preformed] [Job formed or preformed]**.

G. Colors: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample]** <**Insert colors**>.

2.3 THERMOPLASTIC-RUBBER BASE **[RLB-[##]]**

A. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).

1. Group: **[I (solid, homogeneous)] [or] [II (layered)]**.
2. Style and Location:

a. Style A, Straight: Provide in areas with carpet.
b. Style B, Cove: Provide in areas with hard surface floor coverings.

B. Thickness: **[3.2 mm (0.125 inch)]** <**Insert dimension**>.

C. Height: [**102 mm (4 inches)**] [As indicated on Drawings].

D. Lengths: Coils in manufacturer's standard length.

E. Outside Corners: **[Job formed] [Preformed] [Job formed or preformed]**.

F. Inside Corners: **[Job formed] [Preformed] [Job formed or preformed]**.

G. Colors: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] <Insert colors>**.

2.4 RUBBER STAIR ACCESSORIES **[RLG-[##]]**

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Stair Treads: ASTM F 2169.

1. Type: [TS (rubber, vulcanized thermoset)] [or] [TP (rubber, thermoplastic)].
2. Class: 2 (pattern; embossed, grooved, or ribbed).
3. Group: **[1 (embedded abrasive strips)] [2 (with contrasting color for the visually impaired)].**
4. **Nosing Style: [Square, adjustable to cover angles between 60 and 90 degrees] [Square] [Round]**.
5. Nosing Height: **[38 mm (1-1/2 inches)] [51 mm (2 inches)] [56 mm (2-3/16 inches)] <Insert dimension>**.
6. Thickness: **[6 mm (1/4 inch) and tapered to back edge] <Insert thickness>**.
7. Size: Lengths and depths to fit each stair tread in **[one piece] [one piece or, for treads exceeding maximum lengths manufactured, in equal-length units]**.

8. Integral Risers: Smooth, flat; in height that fully covers substrate.

C. Separate Risers: Smooth, flat; in height that fully covers substrate; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.

1. Style: **[Coved toe, 178 mm (7 inches) high by length matching treads] [Toeless, by length matching treads]**.
2. Thickness: **[3.2 mm (0.125 inch)] [Manufacturer's standard] <Insert thickness>**.

D. Stringers: Height and length after cutting to fit risers and treads and to cover stair stringers, produced by same manufacturer as treads, and recommended by manufacturer for installation with treads.

1. Thickness: **[3.2 mm (0.125 inch)] [2.0 mm (0.080 inch)] [Manufacturer's standard] <Insert thickness>**.

E. Landing Tile: Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.

F. Locations: **[Provide rubber stair accessories in areas indicated] <Insert requirements>**.

G. Colors and Patterns: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] <Insert colors and patterns>**.

2.5 RUBBER MOLDING ACCESSORY **[RLG-[##]]**

A. Description: Rubber **[stair-tread nosing] [cap for cove carpet] [cap for cove resilient floor covering] [carpet bar for tackless installations] [carpet edge for glue-down applications] [nosing for carpet] [nosing for resilient floor covering] [reducer strip for resilient floor covering] [joiner for tile and carpet] [transition strips] <Insert description>**.

B. Profile and Dimensions: **[As indicated] <Insert profile and dimensions>**.

C. Locations: **[Provide rubber molding accessories in areas indicated] <Insert requirements>**.

D. Colors and Patterns: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] <Insert colors and patterns>**.

2.6 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of **[50] <Insert value>** g/L or less**[and 60 g/L or less for rubber stair treads]**.

C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Metal Edge Strips: **[Extruded aluminum with mill finish] <Insert requirements>**, nominal 50.8 mm (2 inches) wide, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than **[9] [10]** <**Insert number**> pH.
4. Moisture Testing: Perform tests so that each test area does not exceed **[18.6 sq. m (200 sq. ft.)] [304.8 sq. m (1000 sq. ft.)]** <**Insert area**>, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **[1.36 kg of water/92.9 sq. m (3 lb of water/1000 sq. ft.)] <Insert rate>** in 24 hours.

b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum **[75]** <**Insert number**> percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than **[76 mm (3 inches)]** <**Insert dimension**> in length.

a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than **[76 mm (3 inches)]** <**Insert dimension**> in length.

a. **[Miter] [Cope] [Miter or cope]** corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, adhesive, and blemishes from resilient stair treads before applying liquid floor polish.

1. Apply **[one] [two] [three]** <**Insert requirement**> coat(s).

E. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096536 - STATIC-CONTROL RESILIENT FLOOR COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Static-dissipative, solid vinyl floor tile.
2. Static-dissipative, vinyl composition floor tile.
3. Static-dissipative, vinyl sheet floor covering.

B. Material Index / Material Codes Include:

1. RSF-[##] < STATIC-DISSIPATIVE RESILIENT FLOORING.>

C. Related Requirements:

1. Division 09 Section on "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with static-control resilient floor coverings.
2. Division 27 Section on “Grounding and Bonding for Communications Systems.”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to static-control resilient flooring including, but not limited to, the following:

a. Examination and preparation of substrates to receive static-control resilient flooring.
b. Installation techniques required for specified products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Sustainable Design Submittals:

1. Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.
2. Credit MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

3. Credit MR 6: For products and materials made from rapidly renewable resources, include statement from manufacturer indicating the percentage by weight that is considered rapidly renewable.
4. Credit EQ 4.1: For adhesives and sealants used inside the weatherproofing system, include printed statement of VOC content.
5. Credit EQ 4.3: For hard surface flooring systems, include documentation from an independent testing agency indicating compliance with the FloorScore Standard. For flooring system finishes, include printed statement of VOC content.

C. Shop Drawings: For each type of floor covering. Include floor covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

1. Show details of special patterns.
2. Show locations of inscribed maintenance floor tiles in conductive, solid vinyl floor tile installation areas.
3. Submit grounding diagram showing location of grounding strips and connections.

D. Samples for Verification: For each type of floor covering and in each color, pattern, and texture required, of size indicated below:

1. Floor Tile: **[Full-size] [150-by-230-mm (6-by-9-inch)] <Insert size>** units.
2. Sheet Floor Covering: **[150-by-230-mm (6-by-9-inch)] <Insert dimensions>** sections of floor covering.
3. Heat-Welding Bead: Include Samples of each color required, not less than **[230 mm (9 inches)] <Insert dimension>** long.
4. Seam Samples: For seamless-installation technique indicated and for each static-control resilient flooring product, color, pattern, and texture required; with seam running lengthwise and in center of **[152-by-230-mm (6-by-9-inch)] <Insert dimensions>** Sample applied to a rigid backing and prepared by Installer for this Project.

E. Product Schedule: For floor covering. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by qualified testing agency, for floor coverings.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of floor covering to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
2. Sheet Floor Covering: Furnish not less than 3 linear m (10 linear ft.) for every 150 linear m (500 linear ft.), or fraction thereof, in roll form and in full roll width for each color, pattern, and type of sheet floor covering installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in installation techniques required by manufacturer for floor covering installation indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for static-control resilient flooring including**[integral-flash-cove base and][resilient base and]** accessories.

a. Size: Minimum 9.3 sq. m (100 sq. ft.) for each type, color, and pattern **[in locations indicated] [in locations directed by Project Director/COR, based on input from the A/E of Record] <Insert requirements>**.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store floor coverings and installation materials in dry spaces protected from weather, with ambient temperatures maintained within range recommended by manufacturer but not less than 10 deg C (50 deg F) or more than 32 deg C (90 deg F).

1. Floor Tile: Store on flat surfaces.
2. Sheet Floor Covering: Store rolls upright.

1.9 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 20 deg C (70 deg F) or more than 30 deg C (85 deg F), in spaces to receive floor coverings during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures in installation areas within range recommended by manufacturer, but not less than 13 deg C (55 deg F) or more than 35 deg C (95 deg F).

C. Close spaces to traffic during floor covering installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install floor coverings after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 STATIC-DISSIPATIVE RESILIENT FLOORING, GENERAL

A. Source Limitations: Obtain floor tile from single source from single manufacturer.

B. Static-Control Properties: As determined by testing identical products in accordance with test method indicated by an independent testing and inspecting agency.

1. Electrical Resistance: Test in accordance with ASTM F 150 with 100-V applied voltage.

a. Material: Point-to-point and point-to-ground resistances between 1,000,000 ohms and 1,000,000,000 ohms when tested in accordance with **[ASTM F150] [ESD STM7.1] [UL 779] <Insert requirements>**.
b. Material in Combination with a Person: Average resistance of 1,000,000 ohms when tested in accordance with ESD STM97.1.

2. Static Generation:

a. ESD STM97.2: Less than 30 V when tested at 12 percent relative humidity with static-control footwear.
b. AATCC TM134: Less than 300 V when tested at 20 percent relative humidity with static-control footwear.

3. Static Decay: 5000 to 0 V in less than 0.25 seconds when tested in accordance with FED-STD-101C, Method 4046.1.

C. Critical Radiant Flux: **[0.45 W/sq. cm] [0.22 W/sq. cm]** or greater when tested in accordance with ASTM E648 or NFPA 253.

2.2 STATIC-CONTROL, SOLID VINYL FLOOR TILE: **RSF-[##]**

A. Construction: **[ASTM F1700, Class I (monolithic), Type A (smooth surface)] [Manufacturer's standard, high-density vinyl resin with smooth surface] [Manufacturer's standard, high-density vinyl resin with smooth surface and backing for free-lay installation] <Insert requirements>**.

B. Thickness: **[Manufacturer's standard, but not less than 0.08 inch (2.0 mm)] [0.08 inch (2.0 mm)] [0.13 inch (3.2 mm)] <Insert dimension>**.

C. Size: **[12 by 12 inches (305 by 305 mm)] [24 by 24 inches (610 by 610 mm)] [36 by 36 inches (914 by 914 mm)] <Insert dimensions>**.

D. Seaming Method: **[Heat welded] [Chemically bonded] [Manufacturer's standard] <Insert requirements>**.

E. Colors and Patterns: **[Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]<Insert requirements>**.

2.3 STATIC-CONTROL, VINYL COMPOSITION FLOOR TILE: **RSF-[##]**

A. Construction: ASTM F1066 Class 2, vinyl composition floor tile, through pattern.

B. Thickness: **[1/8 inch (3.2 mm)] <Insert dimension>**.

C. Size: **[12 by 12 inches (305 by 305 mm)] <Insert dimensions>**.

D. Colors and Patterns: **[Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]<Insert requirements>**.

2.4 STATIC-CONTROL, VINYL SHEET FLOOR COVERING: **RSF-[##]**

A. Construction: **[ASTM F1913, unbacked sheet vinyl flooring] [ASTM F1303 Type II, Grade I, Class B, sheet vinyl flooring with nonfoamed plastic backing] [Manufacturer's standard high-density vinyl resin with smooth surface] <Insert requirements>**.

B. Thickness: **[Manufacturer's standard, but not less than 0.08 inch (2.0 mm)] <Insert dimension>**.

C. Size: Manufacturer's standard roll width and length.

D. Seaming Method: **[Heat welded] [Manufacturer's standard] <Insert requirements>**.

E. Colors and Patterns: **[Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]<Insert requirements>**.

2.5 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Static-Control Adhesive: Provided or approved by manufacturer; type that maintains electrical continuity of floor covering system to ground connection.

C. Grounding Strips: Provided or approved by manufacturer; type and size that maintains electrical continuity of floor covering system to ground connection.

D. Seamless-Installation Accessories:

1. Heat-Welding Bead: Solid-strand product of manufacturer for heat welding seams.

a. Color: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] [Match floor covering] <Insert color>**.

2. Chemical-Bonding Compound: Product of manufacturer for chemically bonding seams.

E. Integral-Flash-Cove Base Accessories:

1. Cove Strip: 1-inch (25-mm) radius support strip provided or approved by manufacturer.
2. Cap Strip: **[Square metal, vinyl, or rubber cap] [Tapered vinyl cap] <Insert requirements>** provided or approved by manufacturer.
3. Corners: Metal inside and outside corners and end stops provided or approved by floor-covering manufacturer.

F. Floor Polish: If recommended in writing by manufacturer, provide protective, static-control liquid floor polish products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion or static-control characteristics of floor coverings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings and electrical continuity of floor covering systems.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended in writing by manufacturer. Proceed with installation only after substrates pass testing.
4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.

D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

E. Do not install floor coverings until they are same temperature as space where they are to be installed.

1. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

F. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.3 INSTALLATION, GENERAL

A. Install static-control resilient floor covering according to manufacturer's written instructions.

B. Embed grounding strips in static-control adhesive. Extend grounding strips beyond perimeter of static-control resilient floor covering surfaces to ground connections. Refer to Division 27 Section on “Grounding and Bonding for Communications Systems” for final ground connection.

C. Scribe, cut, and fit floor coverings to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

D. Extend floor coverings into toe spaces, door reveals, closets, and similar openings. Extend floor covering to center of door openings.

E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

F. If applicable, install floor coverings on covers for telephone and electrical ducts, and similar items in installation areas. Maintain overall continuity of color and pattern with pieces of floor coverings installed on covers. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.

G. Adhere floor coverings to substrates using a full spread of static-control adhesive applied to substrate, or other means as recommended by manufacturer, to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

H. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor-covering surfaces.
2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on floor-covering surfaces.

I. Integral-Flash-Cove Base: Cove static-control flooring **[4 inches (102 mm)] [6 inches (152 mm)] [to dimension indicated on Drawings] <Insert dimension>** up vertical surfaces. Support static-control resilient flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

1. Install metal corners at inside and outside corners according to manufacturer's written instructions.

3.4 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.

1. Lay floor tiles square with room axis.

C. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

3.5 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to test electrical resistance of static-control resilient floor covering systems for compliance with requirements.

1. Arrange for testing after installation static-control adhesives have fully cured and floor covering systems have stabilized to ambient conditions and after ground connections are completed.
2. Arrange for testing of floor coverings after performing floor polish procedures (if polishing is recommended by manufacturer).

B. Static-control resilient floor coverings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.

B. Perform the following operations immediately after completing floor covering installation:

1. Remove static-control adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

1. Do not wax static-control resilient floor coverings.
2. If recommended in writing by manufacturer, apply protective static-control floor polish formulated to maintain or enhance floor covering's electrical properties. Before polishing, do the following:

a. Ensure that static-control resilient flooring surfaces are free from soil, static-control adhesive, and surface blemishes.
b. Verify that both floor polish and its application method are approved by manufacturer, and that floor polish will not leave insulating film that reduces floor coverings' effectiveness for static control.

D. Cover floor coverings and protect from rolling loads until Substantial Completion.

END OF SECTION 096536

SECTION 096623 - RESINOUS MATRIX TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thin-set, epoxy-resin terrazzo flooring.
2. Precast epoxy-resin terrazzo units.

B. Material Index / Material Codes Include:

1. TZF-[##] <RESINOUS MATRIX TERRAZZO.>

C. Related Requirements:

1. Division 07 Section on "Joint Sealants" for sealants installed with terrazzo.
2. Division 09 Section on "Resinous Flooring" for decorative resinous flooring systems applied as self-leveling slurries or as troweled or screeded mortars.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to terrazzo including, but not limited to, the following:

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Review special terrazzo designs and patterns.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

3. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include terrazzo installation requirements. Include plans, sections, component details, and relationship to other work. Show layout of the following:

1. Divider strips.
2. Control-joint strips.
3. Accessory strips.
4. Abrasive strips.
5. Stair treads, risers, and landings.
6. Precast terrazzo jointing and edge configurations.
7. Terrazzo patterns.

D. Samples for Verification: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo Sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in sizes indicated below:

1. Terrazzo: 300-mm- (12-inch) square Samples.
2. Precast Terrazzo: 300-mm- (12-inch) square Samples.
3. Accessories: 150-mm- (6-inch-) long Samples of each exposed strip item required.
4. Stair Treads and Risers: 300 mm length wide sample combination tread/riser with cast-in nosing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each type of terrazzo material or product.

C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

D. Preinstallation moisture-testing reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For terrazzo to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
2. Engage an installer who is a contract member of NTMA or equivalent trade association.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for terrazzo including accessories.

a. Size: Minimum 9 sq. m (100 sq. ft.) of typical poured-in-place flooring**[and base]** condition for each color and pattern in locations indicated.
b. Include **[base] [first three stair treads] <Insert item>**.
c. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

C. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

D. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.

E. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain primary terrazzo materials from single source from single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.

B. Source Limitations for Aggregates: Obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. NTMA Standards: Comply with NTMA's written recommendations for terrazzo type indicated unless more stringent requirements are specified.

2.3 EPOXY-RESIN TERRAZZO

A. Epoxy-Resin Terrazzo **TZF-[##]**: Comply with manufacturer's written instructions for matrix and aggregate proportions and mixing.

B. Mix Color and Pattern: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range].**

C. Materials:

1. Moisture-Vapor-Emission-Control Membrane: Two-component, high-solids, high-density, low-odor, epoxy-based membrane-forming product produced by epoxy terrazzo manufacturer that reduces moisture emission from concrete substrate to not more than 1.36 kg of water/92.9 sq. m (3 lb of water/1000 sq. ft.) in 24 hours.
2. Substrate-Crack-Suppression Membrane: Product of terrazzo-resin manufacturer, having minimum 120 percent elongation potential according to ASTM D412.

   a. Reinforcement: Fiberglass scrim.

3. Primer: Manufacturer's product recommended for substrate and use indicated.
4. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.

   a. Physical Properties without Aggregates:

      1) Hardness: 60 to 85 per ASTM D2240, Shore D.

2) Minimum Tensile Strength: 20.7 MPa (3000 psi) per ASTM D638 for a 51-mm (2-inch) specimen made using a "C" die per ASTM D412.
3) Minimum Compressive Strength: 6.9 MPa (10,000 psi) per ASTM D695, Specimen B cylinder.
4) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D1308.

a) Distilled water.
b) Mineral water.
c) Isopropanol.
d) Ethanol.
e) 0.025 percent detergent solution.
f) 1.0 percent soap solution.
g) 5 percent acetic acid.
h) 10 percent sodium hydroxide.
i) 10 percent hydrochloric acid.
j) 30 percent sulfuric acid.

b. Physical Properties with Aggregates: For terrazzo blended according to manufacturer's recommendations with one part epoxy resin with three parts marble aggregate consisting of 60 percent No. 1 chips and 40 percent No. 0 chips that is ground and grouted to a 6.35-mm (1/4-inch) nominal thickness, and cured for 7 days at 24 deg C (75 deg F) plus or minus 1 deg C (2 deg F) and at 50 percent plus or minus 2 percent relative humidity.

1) Flammability: Self-extinguishing, maximum extent of burning 6.35 mm (1/4 inch) according to ASTM D635.
2) Thermal Coefficient of Linear Expansion: 0.0025 mm/mm per 0.5556 deg C (0.0025 inch/inch per deg F) according to ASTM C531.

5. Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.

a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C131/C131M.
b. 24-Hour Absorption Rate: Less than 0.75 percent.
c. Dust Content: Less than 1.0 percent by weight.

6. Finishing Grout: Resin based.

2.4 PRECAST EPOXY-RESIN TERRAZZO**:**

A. Precast Terrazzo Base **TZF-[##]**: Minimum 10-mm- (3/8-inch-) thick, epoxy terrazzo units cast in maximum lengths possible, but not less than 900 mm (36 inches). Comply with manufacturer's written instructions for fabricating precast terrazzo base units in sizes and profiles indicated.

1. Type: [**As indicated**] [**Coved with minimum 19-mm (3/4-inch) radius**] [**Straight**] [**Splayed**] <**Insert requirements**>.

2. Top Edge: **[Straight, unfinished] [Beveled with polished top surface] [Radius edge with polished top surface] <Insert requirements>**.

3. Metal Toe Strip: **[Zinc] [Brass]**.
4. Outside Corner Units: With finished returned edges at outside corner.
5. Color, Pattern, and Finish: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range].**

B. Precast Terrazzo Units **TZF-[##]**: Minimum [**19-mm (3/4-inch)**] <**Insert dimension**> thick, epoxy terrazzo units. Comply with manufacturer's written instructions for fabricating precast units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to 3.2-mm (1/8-inch) radius.

1. Color, Pattern, and Finish: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range].**

2.5 STRIP MATERIALS

A. Thin-Set Divider Strips: L-type angle in depth required for topping thickness indicated.

1. Material: **[As indicated] [White-zinc alloy] [Brass] [Aluminum] [Plastic, in color selected from full range of industry colors] <Insert requirements>**.
2. Top Width: **[As indicated] [3.2 mm (1/8 inch)] [6.4 mm (1/4 inch)] <Insert dimension>**.

B. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.

1. Bottom-Section Material: **[As indicated] [Galvanized steel] [Matching top-section material] <Insert requirements>**.
2. Top-Section Material: **[As indicated] [White-zinc alloy] [Brass] [Aluminum] [Plastic, in color selected from full range of industry colors] <Insert requirements>**.
3. Top-Section Width: **[As indicated] [3.2 mm (1/8 inch)] [6.4 mm (1/4 inch)] [9.5 mm (3/8 inch)] [12.7 mm (1/2 inch)] <Insert dimension>**.

C. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.

D. Accessory Strips: Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:

1. Base-bead strips for exposed top edge of terrazzo base.
2. Edge-bead strips for exposed edges of terrazzo.
3. Nosings for terrazzo stair treads and landings.
4. **<Insert requirements>**.

E. Abrasive Strips: [**Three-line**] [**Two-line**] [**One-line**] [**Abrasive nosing strip and two-line**] <**Insert requirements**> abrasive inserts at nosings. Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.

1. Width: **[12.7 mm (1/2 inch)] <Insert dimension>**.
2. Depth: As required by terrazzo thickness.
3. Length: **[100 mm (4 inches) less than stair width] [As indicated] <Insert dimension>**.
4. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]**.

2.6 MISCELLANEOUS ACCESSORIES

A. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use.

B. Anchoring Devices:

1. Strips: Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and as required for secure attachment to substrate.
2. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.

C. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

D. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

E. Resinous Matrix Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

F. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; and is recommended by sealer manufacturer.

1. Surface Friction: Not less than 0.6 according to ASTM D2047.
2. Acid-Base Properties: With pH factor between 7 and 10.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.2 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

B. Concrete Slabs:

1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.

a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written instructions.
c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.

C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

D. Preinstallation Moisture Testing:

1. Testing Agency: Engage a qualified testing agency to perform tests.
2. Moisture Testing: Perform tests so that each test area does not exceed 18.6 sq. m (200 sq. ft.), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Moisture-Vapor-Emission Test: Maximum moisture-vapor-emission rate of 1.36 kg of water/92.9 sq. m (3 lb of water/1000 sq. ft.) in 24 hours when tested according to ASTM F1869 using anhydrous calcium chloride.
b. Relative Humidity Test: Maximum 75 percent relative humidity measurement when tested according to ASTM F2170 using in-situ probes.

3. Proceed with terrazzo installation only after concrete substrates pass moisture testing or after installation of moisture-vapor-emission-control membrane on substrate areas that fail testing.

E. Moisture-Vapor-Emission-Control Membrane: Install according to manufacturer's written instructions.

1. Install on concrete substrates that incorporate lightweight aggregates.
2. Install concrete substrates that fail preinstallation moisture testing.

F. Substrate-Crack-Suppression Membrane: Install to isolate and suppress substrate cracks according to manufacturer's written instructions.

1. Prepare and prefill substrate cracks with membrane material.
2. Install membrane **[at substrate cracks] [to produce full substrate coverage]** in areas to receive terrazzo.
3. Reinforce membrane with fiberglass scrim.

G. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.

1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 EPOXY-RESIN TERRAZZO INSTALLATION

A. Comply with NTMA's written recommendations for terrazzo and accessory installation.

B. Strip Materials:

1. Divider and Control-Joint Strips:

a. Locate divider strips in locations indicated.
b. Install control-joint strips **[back to back and directly above concrete-slab control joints] [in locations indicated]**.
c. Install control-joint strips with 6.4-mm (1/4-inch) gap between strips, and install sealant in gap.
d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.

2. Accessory Strips: Install **[as required to provide a complete installation] [in locations indicated]**.
3. Abrasive Strips: Install with surface of abrasive strip positioned 1.6 mm (1/16 inch) higher than terrazzo surface.
4. Sealant joint to match color of divider strips and be applied smooth and flush with exposed edges of divider strips to avoid visible surface irregularity and voids in joint.

C. Apply primer to terrazzo substrates according to manufacturer's written instructions.

D. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions.

1. Installed Thickness: [**6.4 mm (1/4 inch)**] [**9.5 mm (3/8 inch)**] [**As indicated on Drawings**] <**Insert dimension**> nominal.

2. Terrazzo Finishing: Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.

a. Rough Grinding: Grind with 24-grit or finer stones or with comparable diamond abrasives. Follow initial grind with 60/80-grit stones or with comparable diamond abrasives.
b. Grouting: Before grouting, clean terrazzo with water, rinse, and allow to dry. Apply and cure epoxy grout.
c. Fine Grinding/Polishing: Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted. Grind with 80-grit stones or with comparable diamond abrasives until grout is removed from surface.

3. Installation Tolerance: Limit variation in terrazzo surface from level to 6.4 mm in 3 m (1/4 inch in 10 feet); noncumulative.

E. Install and finish poured-in-place terrazzo stairs at the same time the adjacent terrazzo flooring is installed.

F. Install and finish poured-in-place terrazzo base at the same time the adjacent terrazzo flooring is installed.

3.4 PRECAST TERRAZZO INSTALLATION

A. Install precast terrazzo units using method recommended in writing by NTMA and manufacturer unless otherwise indicated.

B. Do not install units that are chipped, cracked, discolored, or improperly finished.

C. Seal joints between units with [**joint compound matching precast terrazzo matrix**] [**joint sealant**].

3.5 REPAIR

A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by **Project Director/COR**.

3.6 CLEANING AND PROTECTION

A. Cleaning:

1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Sealing:

1. Seal surfaces according to NTMA's written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 096623

SECTION 096800 - CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Broadloom carpet.
2. Carpet tile.
3. Static-Dissipative Carpet Tile
4. Carpet cushion.

B. Material Index / Material Codes Include:

1. CBF-[##] <BROADLOOM CARPET.>
2. CTF-[##] <CARPET TILE.>
3. CSF-[##] <STATIC DISSIPATIVE CARPET TILE.>

C. Related Requirements:

1. Division 09 Section on "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet.
2. [Division 09 Section on “Access Flooring.”]
3. Division 09 Section on “Static-Control Resilient Floor Coverings” for static-dissipative rubber tile flooring.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.
d. Review installation pattern for carpet tile
e. Review methods and procedures related to static-dissipative carpet tile including, but not limited to, examination and preparation of substrates to receive static-dissipative carpet tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.
3. Include manufacturer’s written installation recommendations for carpet tile pattern installation methods.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For carpet installation, showing the following:

1. Broadloom Carpet:

a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
b. Carpet type, color, and dye lot.

c. **[Locations where dye lot changes occur.]**
d. Seam locations, types, and methods.
e. Type of subfloor.
f. Type of installation.
g. Pattern type, repeat size, location, direction, and starting point.
h. Pile direction.
i. Types, colors, and locations of insets and borders.
j. Types, colors, and locations of edge, transition, and other accessory strips.
k. Transition details to other flooring materials.

l. Type of carpet cushion.

2. Carpet Tile:

a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.

b. Carpet tile type, color, and dye lot.

c. **[Locations where dye lot changes occur.]**
d. Seam locations, types, and methods.
e. Type of subfloor.
f. Type of installation.
g. Pattern type, repeat size, location, direction, and starting point.
h. Pile direction.
i. Types, colors, and locations of insets and borders.
j. Types, colors, and locations of edge, transition, and other accessory strips.
k. Transition details to other flooring materials.

D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Broadloom Carpet: 300-mm- (12-inch-) square Sample.
2. Carpet Tile: Full-size Sample.
3. Exposed Edge, Transition, and Other Accessory Stripping: 300-mm- (12-inch-) long Samples.
4. Carpet Cushion: 150-mm- (6-inch-) square Sample.
5. Carpet Seam: 150-mm (6-inch) Sample.
6. Mitered Carpet-Border Seam: 300-mm- (12-inch-) square Sample. Show carpet pattern alignment.

E. Product Schedule: For carpet**[and carpet cushion]**. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet**[and carpet cushion]**, for tests performed by a qualified testing agency.

C. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.

2. Precautions for cleaning materials and methods that could be detrimental to carpet**[and carpet cushion]**.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Broadloom Carpet: Full-width rolls equal to 5 percent of amount installed for each type indicated, but not less than 8.3 sq. m (10 sq. yd.).
2. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 8.3 sq. m (10 sq. yd.).
3. Do not sell extra materials during sales of warehouse stock.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the **[Commercial II] [Master II] <Insert description>** certification level.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups at locations and in sizes shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI's "CRI Carpet Installation Standard."

B. Deliver carpet in original mill protective covering with mill register numbers and tags attached.

1.9 FIELD CONDITIONS

A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet**[and carpet cushion]** until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. **[Do not install carpet[and carpet cushion] over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.]**

D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.10 WARRANTY

A. Special Warranty for Broadloom Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
b. Loss of tuft bind strength.
c. Excess static discharge.
d. Delamination.

3. Warranty Period: Minimum 10 years from date of Substantial Completion.

B. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent edge raveling, snags, and runs.
b. Dimensional instability.
c. Excess static discharge.
d. Loss of tuft-bind strength.
e. Loss of face fiber.
f. Delamination.

3. Warranty Period: Minimum 10 years from date of Substantial Completion.

C. Special Warranty for Carpet Cushion: Manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.

1. Warranty includes removal and replacement of carpet and accessories required by replacement of carpet cushion.
2. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
3. Failure includes, but is not limited to, permanent indentation or compression.

4. Warranty Period: Minimum 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BROADLOOM CARPET, TUFTED **[CBF-[##]]**:

A. Color: **[As indicated by manufacturer's designations][Match Project Director/COR's samples][As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

B. Pattern: **[Match Project Director/COR's samples] <Insert pattern>**.

C. Fiber Content: **[100 percent nylon 6, 6] [100 percent nylon 6] [100 percent polypropylene] <Insert fiber and content by percentage>**.

D. Fiber Type: **<Insert proprietary fiber type>**.

E. Pile Characteristic: **[Level-loop][Cut][Cut-and-loop][Multilevel-loop][Level tip shear] [Random shear][Frieze][Sculptured] <Insert characteristic>** pile.

F. Yarn Twist: **<Insert twist in TPCM (TPI)>**.

G. Yarn Count: **<Insert yarn count>**.

H. Density: **<Insert g/cu. cm (oz./cu. yd.)>**.

I. Pile Thickness: **<Insert mm (inches)>** for finished carpet**[according to ASTM D 6859]**.

J. Stitches: **<Insert stitches per mm (inch)>**.

K. Gage: **<Insert gage in ends per mm (inch)>**.

L. Face Weight: **<Insert g/sq. m (oz./sq. yd.)>**.

M. Total Weight: **<Insert g/sq. m (oz./sq. yd.)>** for finished carpet.

N. Primary Backing: **[Manufacturer's standard material][Woven polypropylene][Nonwoven, polypropylene or polyester] <Insert specific primary backing material>**.

O. Secondary Backing: **[Manufacturer's standard material][Woven polypropylene] [Nonwoven, polypropylene or polyester][Woven jute][Fiberglass] <Insert specific secondary backing material>**.

P. Backcoating: **[Manufacturer's standard material][SBR latex][PVC][Thermoplastic copolymer] <Insert backcoating; consult manufacturers>**.

Q. Roll Width: **[3.7 m (12 feet)][1.8 m (6 feet)][4.1 m (13.5 feet)][4.6 m (15 feet)] <Insert dimension>**.

R. Applied Treatments:

1. Applied Soil-Resistance Treatment: Manufacturer's standard material.

2. Antimicrobial Treatment: Manufacturer's standard material.

   a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

S. Sustainable Design Requirements:

1. Sustainable Product Certification: **[Silver] [Gold] [Platinum]** level certification according to ANSI/NSF 140.
2. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

T. Performance Characteristics:

1. Appearance Retention Rating: [**Moderate traffic, 2.5**] **[Heavy traffic, 3.0] [Severe traffic, 3.5]** minimum according to ASTM D 7330.
2. Critical Radiant Flux Classification: Not less than **[0.45 W/sq. cm] [0.22 W/sq. cm]** according to NFPA 253.
3. Dry Breaking Strength: Not less than 445 N (100 lbf) according to ASTM D 2646.

4. Tuft Bind: Not less **than [22 N (5 lbf)] [28 N (6.2 lbf)] [36 N (8 lbf)] [45 N (10 lbf)] <Insert value>** according to ASTM D 1335.

5. Delamination: Not less than **[0.4 N/mm (2.5 lbf/in.)] [0.6 N/mm (3.5 lbf/in.)] [.07 N/mm (4 lbf/in.)] <Insert value>** according to ASTM D 3936.
6. Noise Reduction Coefficient (NRC): **<Insert NRC>** according to ASTM C 423.
7. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.

8. Colorfastness to Light: Not less than 4 after **[40][60]**<**Insert number**> AFU (AATCC fading units) according to AATCC 16, Option E.

9. Electrostatic Propensity: Less than **[3.5][2]<Insert number>** kV according to AATCC 134.

2.2 CARPET TILE **[CTF-[##] OR CSF-[##]]**:

A. Color: **[As indicated by manufacturer's designations] [Match Project Director/COR's samples][As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

B. Pattern: **[Match Project Director/COR's samples] <Insert pattern>**.

C. Fiber Content: **[100 percent nylon 6, 6] [100 percent nylon 6] [100 percent polypropylene] [100 percent wool] [80 percent wool; 20 percent nylon 6, 6] [80 percent wool; 20 percent nylon 6] <Insert percentage>**.

D. Fiber Type: **<Insert proprietary fiber type>**.

E. Pile Characteristic: **[Level-loop] [Cut] [Cut-and-loop] <Insert construction>** pile.

F. Yarn Twist: **<Insert TPCM (TPI)>**.

G. Yarn Count: **<Insert count>**.

H. Density: **<Insert g/cu. cm (oz./cu. yd.)>**.

I. Pile Thickness: **<Insert mm (inches)>** for finished carpet tile**[according to ASTM D 6859]**.

J. Stitches: **<Insert stitches per mm (inch)>**.

K. Gage: **<Insert ends per mm (inch)>**.

L. Surface Pile Weight: **<Insert g/sq. m (oz./sq. yd.)>**.

M. Total Weight: **<Insert g/sq. m (oz./sq. yd.)>** for finished carpet tile.

N. Primary Backing/Backcoating: **[Manufacturer's standard composite materials][PVC][Fiberglass-reinforced PVC][Fiberglass-reinforced amorphous resin][Reinforced polyurethane composite cushion][Reinforced polyurethane composite][Reinforced thermoplastic copolymer] <Insert specific primary backing materials; consult manufacturers>**.

O. Secondary Backing: **[Manufacturer's standard material] <Insert specific secondary backing material>**.

P. Backing System: **<Insert proprietary name>**.

Q. Size: **[457 by 457 mm (18 by 18 inches)] [610 by 610 mm (24 by 24 inches)] [457 by 914 mm (18 by 36 inches)] [914 by 914 mm (36 by 36 inches)] <Insert dimensions>**.

R. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.

2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:

   a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

S. Sustainable Design Requirements:

1. Sustainable Product Certification: **[Silver] [Gold] [Platinum]** level certification according to ANSI/NSF 140.
2. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

T. Performance Characteristics:

1. Appearance Retention Rating: [**Moderate traffic, 2.5**] **[Heavy traffic, 3.0] [Severe traffic, 3.5]** minimum according to ASTM D 7330.
2. Critical Radiant Flux Classification: Not less than **[0.45 W/sq. cm] [0.22 W/sq. cm]** according to NFPA 253.
3. Dry Breaking Strength: Not less than 445 N (100 lbf) according to ASTM D 2646.
4. Tuft Bind: Not less than **[22 N (5 lbf)] [28 N (6.2 lbf)] [36 N (8 lbf)] [45 N (10 lbf)] <Insert value>** according to ASTM D 1335.
5. Delamination: Not less than **[0.6 N/mm (3.5 lbf/in.)] [0.7 N/mm (4 lbf/in.)] <Insert value>** according to ASTM D 3936.
6. Dimensional Tolerance: Within 0.8 mm (1/32 inch) of specified size dimensions, as determined by physical measurement.
7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
8. Noise Reduction Coefficient (NRC): **<Insert NRC>** according to ASTM C 423.
9. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
10. Colorfastness to Light: Not less than 4 after **[40] [60]** <**Insert number**> AFU (AATCC fading units) according to AATCC 16, Option E.
11. Electrostatic Propensity: Less than **[3.5] [2]** <**Insert number**> kV according to AATCC 134.

2.3 CARPET CUSHION **<INSERT DESIGNATION>**

A. Traffic Classification: CCC **[Class II, heavy] [Class III, extra-heavy]** traffic.

B. Fiber Cushion: **[Rubberized hair, mothproofed and sterilized] [Rubberized jute, mothproofed and sterilized] [Synthetic] [Resinated, recycled textile].**

1. Weight: **<Insert g/sq. m (oz./sq. yd.)>**.

2. Thickness: **<Insert mm (inches)>** plus 5 percent maximum.
3. Density: **<Insert kg/cu. m (lb/cu. ft.)>**.

C. Rubber Cushion: **[Flat] [Rippled waffle] [Textured flat] [Reinforced]**.

1. Weight: **<Insert g/sq. m (oz./sq. yd.)>**.
2. Thickness: **<Insert mm (inches)>** plus 5 percent maximum.
3. Compression Resistance: **<Insert kg/sq. mm (lb/sq. in.)>** at **[25] [65]** percent according to ASTM D 3676.
4. Density: **<Insert kg/cu. m (lb/cu. ft.)>**.

D. Polyurethane-Foam Cushion: **[Grafted prime] [Densified] [Bonded] [Mechanically frothed]**.

1. Compression Force Deflection at 65 Percent: **<Insert kg/sq. mm (lb/sq. in.) of polymer density>** according to ASTM D 3574.
2. Thickness: **<Insert mm (inches)>**.
3. Density: **<Insert kg/cu. m (lb/cu. ft.)>**.

E. Performance Characteristics:

1. Critical Radiant Flux Classification: Not less than **[0.45 W/sq. cm] [0.22 W/sq. cm]** according to NFPA 253.
2. Noise Reduction Coefficient (NRC): **<Insert NRC>** according to ASTM C 423.

3. Flooring products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by **[carpet] [carpet cushion]** manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by **[carpet manufacturer][carpet and carpet cushion manufacturers]**.

1. Adhesive for static-dissipative carpet tile: Conductive releasable adhesive for carpet tile, provided or approved by carpet tile manufacturer, that maintains electrical continuity of floor covering system to ground connection; compliant to 1.0 x 106 ohms RTT.

2. Adhesives shall have a VOC content of **[50]** <**Insert value**> g/L or less.

3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

D. Grounding Strips for Static-Dissipative Carpet Tile: Provided or approved by static-dissipative carpet tile manufacturer; type and size that maintains electrical continuity of floor covering system to ground connection.

E. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance.

B. Examine carpet for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Division 03 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed **[18.6 sq. m (200 sq. ft.)] [304.8 sq. m (1000 sq. ft.)] <Insert area>**, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **[1.36 kg of water/92.9 sq. m (3 lb of water/1000 sq. ft.)] <Insert emission>** in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum **[75] <Insert number>** percent relative humidity level measurement.
c. Perform additional moisture tests recommended in writing by **[adhesive and carpet][adhesive, carpet cushion, and carpet]** manufacturers. Proceed with installation only after substrates pass testing.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI's "CRI Carpet Installation Standard" and with carpet manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 3 mm (1/8 inch) wide or wider, and protrusions more than 0.8 mm (1/32 inch), unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by **[adhesive and carpet] [adhesive, carpet, and carpet cushion]** manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 BROADLOOM CARPET INSTALLATION

A. Comply with CRI's "CRI Carpet Installation Standard" and **[carpet manufacturer's] [carpet and carpet cushion manufacturers']** written installation instructions for the following:

1. Direct-glue-down installation.
2. Carpet with attached-cushion installation.

B. Comply with carpet manufacturer's written instructions and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

C. Install **[pattern parallel to walls and borders][as indicated on Drawings] <Insert requirements>**.

D. Install borders with mitered corner seams.

E. Do not bridge building expansion joints with carpet.

F. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

G. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.

3.4 CARPET TILE INSTALLATION

A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.

B. Installation Methods:

1. Static-Dissipative Carpet Tile:

   a. Coordinate locations of grounding strips with Project Director/COR before beginning installation.
   b. Embed grounding strips in conductive adhesive. Extend grounding strips beyond perimeter of static-dissipative carpet tile surfaces to ground connections.
   c. Ground at frequency of not less than 1 per 100 square meters.
   d. Install every tile with full-spread, conductive adhesive.

2. Other Carpet Tile Types: **[As recommended in writing by carpet tile manufacturer] [Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive] [Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive] [Free lay; install carpet tiles without adhesive]**.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns **[indicated on Drawings] [recommended in writing by carpet tile manufacturer]**.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

I. Lay out tile work to minimize the use of pieces that are less than half of a tile.

J. [Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.]

3.5 FIELD QUALITY CONTROL

A. Testing:

1. Engage a qualified testing agency to test electrical resistance of static-dissipative carpet tile for compliance with requirements.
2. Arrange for testing after installation static-control adhesives have fully cured and carpet tile has stabilized to ambient conditions and after ground connections are completed.

B. Static-dissipative carpet tile will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
2. Remove yarns that protrude from carpet surface.
3. Vacuum carpet using commercial machine with face-beater element.

B. Protect installed carpet to comply with CRI's "CRI Carpet Installation Standard."

C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods recommended in writing by carpet manufacturer **[and carpet cushion manufacturer][and carpet adhesive manufacturer][and carpet cushion and adhesive manufacturers]**.

END OF SECTION 096800

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl wall covering.
2. Textile wall covering.
3. Wallpaper.

B. Material Index / Material Codes Include:

1. WCW-[##] <(VINYL) WALL COVERING.>
2. WCW-[##] <(TEXTILE) WALL COVERING.>
3. **WCW-[##] <(WALLPAPER) WALL COVERING.>**

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.

B. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
3. Product Data: For adhesives, indicating VOC content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Show location and extent of each wall-covering type. Indicate **[pattern placement,]** seams and termination points.

D. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by **[914-mm- (36-inch-)]** <**Insert dimension**> long in size.

1. Wall-Covering Sample: From same production run to be used for the Work, with specified **[treatments] [paint]** applied.**[Show complete pattern repeat.][Mark top and face of fabric.]**

E. Product Schedule: For wall coverings.**[Use same designations indicated on Drawings.]**

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Covering Materials: For each type, color, texture, and finish, full width by length to equal to 5 percent of amount installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Not less than 5 years documented successful experience with work comparable to Work of this Project.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for installation.

1. Build mockups for each type of wall covering on each substrate required. Comply with requirements in ASTM F 1141 for appearance shading characteristics.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

D. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.

B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: **[50] [450]** <**Insert value**> or less.

2.2 VINYL WALL COVERING **[WCW-[##]]**

A. Description: Provide**[mildew-resistant]** products in rolls from same production run and complying with the following:

1. ASTM F 793 for **[peelable] [strippable]** wall coverings.

a. Category: **[I, Decorative Only] [II, Decorative with Medium Serviceability] [III, Decorative with High Serviceability] [IV, Type I, Commercial Serviceability] [V, Type II, Commercial Serviceability] [VI, Type III, Commercial Serviceability]**.

B. Total Weight: <**Insert weight**>, excluding coatings.

C. Width: [**686 mm (27 inches)**] [**1372 mm (54 inches)**] <**Insert dimension**>.

D. Backing: **[Scrim] [Osnaburg] [Drill] [Nonwoven]** fabric.

1. Fiber Content: **[Cotton] [Polyester] [Polycotton] [Polyester cellulose]** <**Insert fiber content**>.

E. Repeat: **[Random]** <**Insert horizontal and vertical dimensions of repeat**>.

F. Stain-Resistant Coating: <**Insert coating manufacturer's name; product name or designation**>.

G. Colors, Textures, and Patterns: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]**.

2.3 TEXTILE WALL COVERING **[WCW-[##]]**

A. Description: Provide **[mildew-resistant,] [peelable] [strippable]** wall coverings in rolls from same production run and that comply with ASTM F 793.

1. Category: **[I, Decorative Only] [II, Decorative with Medium Serviceability] [III, Decorative with High Serviceability] [IV, Type I, Commercial Serviceability] [V, Type II, Commercial Serviceability] [VI, Type III, Commercial Serviceability]**.

B. Test Responses:

1. Colorfastness to Wet and Dry Crocking: Passes AATCC 8, Grade 3, minimum.

2. Colorfastness to Light: Passes AATCC 16, Test Option 1 or 3, Grade 4, minimum, at 40 hours.

C. Total Weight: <**Insert weight**>, excluding coatings.

D. Width: <**Insert width**>.

E. Repeat: **[Random]** <**Insert horizontal and vertical dimensions of repeat**>.

F. Applied Backing Material: **[Acrylic] [Paper]**.

G. Stain-Resistant Coating: <**Insert coating manufacturer's name; product name or designation**>.

H. Colors, Textures, and Patterns: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]**.

2.4 WALLPAPER **[WCW-[##]]**

A. Description: Provide **[mildew-resistant] [peelable] [strippable]** wallpaper in rolls from same production run and that complies with ASTM F 793.

1. Category: **[I, Decorative Only] [II, Decorative with Medium Serviceability] [III, Decorative with High Serviceability]**.

B. Total Weight: <**Insert weight**>.

C. Width: [**520.7 mm (20-1/2 inches)**] [**711.2 mm (28 inches)**] <**Insert dimension**>.

D. Repeat: **[Random]** <**Insert horizontal and vertical dimensions of repeat**>.

E. Colors, Textures, and Patterns: **[Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]**.

2.5 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining**[, strippable]** adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

1. Adhesives shall have a VOC content of **[50]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Primer/Sealer: Mildew resistant, complying with requirements in **[Division 09 Section on "Interior Painting"]** and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

C. Metal Primer: Interior ferrous metal primer complying with **[Division 09 Section on "Interior Painting"]** and recommended in writing by primer and wall-covering manufacturers for intended substrate.

D. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended in writing by wall-covering manufacturer.

1. Adhesives shall have a VOC content of **[50]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.

1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
2. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
3. Metals: If not factory primed, clean and apply primer recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
4. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
5. Painted Surfaces: Treat areas susceptible to pigment bleeding.

D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.

E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 WALL-COVERING INSTALLATION

A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.

B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.

D. Install wall covering without lifted or curling edges and without visible shrinkage.

E. Match pattern **[1830 mm (72 inches)]** <**Insert dimension**> above the finish floor.

F. Install seams vertical and plumb at least 150 mm (6 inches) from outside corners and **[75 mm (3 inches)] [150 mm (6 inches)]** from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.

G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.4 CLEANING

A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200

SECTION 097513 - STONE WALL FACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes dimension stone paneling on interior **[walls] [and] [columns] [, including units with carving or inscriptions]**.

B. Material Index / Material Codes Include:

1. STW-[##] <STONE WALL OR COLUMN.>

C. Related Requirements:

1. Division 03 Section on "Cast-in-Place Concrete" for installing concrete inserts for anchoring stone paneling.
2. **[Division 04 Section on "Unit Masonry" for installing masonry inserts for anchoring stone paneling.]**
3. Division 04 Section on “Exterior Stone Cladding” for exterior stone.
4. Division 09 Section on “Stone Flooring”. Division 07 Section on "Joint Sealants" for sealing joints in stone paneling system with elastomeric sealants.
5. **[Division 09 Section on "Stone Tiling" for stone wall tile.]**

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each**[variety of stone,]** stone accessory, and manufactured product.

B. Sustainable Design Submittals:

1. Product Certificates: For materials manufactured within 100 miles (160 km) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.
2. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Show fabrication and installation details for stone paneling system, including dimensions and profiles of stone units.

1. Show locations and details of joints both within stone paneling system and between stone paneling system and other finish materials.
2. Show locations and details of anchors, including locations of supporting construction.
3. Show direction of veining, grain, or other directional pattern.
4. Include large-scale shaded drawings of [**decorative surfaces**] [**and**] [**inscriptions**].

D. Samples for Verification:

1. For each stone type indicated, in sets of Samples not less than 300 mm (12 inches) square. Include **[two] [three] [four] [five]** <**Insert number**> or more Samples in each set and show the full range of variations in appearance characteristics in completed Work.
2. For each color of **[grout] [pointing mortar] [and] [sealant]** required.
3. For [**carving**] [**and**] [**inscriptions**].

E. Delegated-Design Submittal: For stone paneling assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer**,** fabricator, and professional engineer.

B. Material Test Reports:

1. Stone Test Reports: For**[each]** stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous **[three] [five]** <**Insert number**> years.
2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.
3. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For stone paneling to include in maintenance manuals. Include product data for stone-care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate stone paneling similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of stone paneling. Installer Qualifications: Not less than 5 years documented successful experience with work comparable to Work of this Project.

C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockups of typical wall area as shown on Drawings.
2. Build mockups for the following kinds of stone paneling:

a. Typical stone wall paneling, not less than 1800 mm (72 inches) long by 2400 mm (96 inches) high.
b. Typical stone wainscot paneling, not less than 1800 mm (72 inches) long by full wainscot height.
c. Grouting or pointing of joints.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in sample installations unless Project Director/COR specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Sealant Adhesion and Compatibility Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Division 07 Section on "Joint Sealants," Samples of materials that will contact or affect joint sealants.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

B. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.

C. Deliver sealants to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.

D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.9 FIELD CONDITIONS

A. Maintain air and material temperatures to comply with requirements of installation material manufacturers, but not less than 10 deg C (50 deg F) during installation and for seven days after completion.

B. Field Measurements: Verify dimensions of construction to receive stone paneling by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 COORDINATION

A. Coordinate installation of inserts that are to be embedded in concrete or masonry and similar items to be used by stone paneling Installer for anchoring and supporting stone paneling. Furnish setting drawings, templates, and directions for installing such items and deliver to Project site in time for installation.

B. Time delivery and installation of stone paneling to avoid extended on-site storage and to coordinate with work adjacent to stone paneling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design stone paneling system.

B. General: Design stone anchors and anchoring systems according to ASTM C 1242.

C. Seismic Performance: Stone paneling system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.2 MANUFACTURERS

A. Source Limitations for Stone: Obtain**[each variety of]** stone, **[regardless of finish,]**from single quarry**[, whether specified in this Section or in another Section of the Specifications,]** with resources to provide materials of consistent quality in appearance and physical properties.

1. For stone types that include same list of varieties and sources, provide same variety from same source for each.

2. Make stone slabs available for examination by Project Director/COR.

a. Project Director/COR, based on input from the A/E of Record, will select aesthetically acceptable slabs**[and will indicate aesthetically unacceptable portions of slabs]**.
b. Segregate slabs selected for use on Project and mark backs indicating approval.

c. Mark and photograph aesthetically unacceptable portions of slabs as directed by Project Director/COR.

B. **[Varieties and Sources: Subject to compliance with requirements, provide stone of varieties and from sources complying with Division 04 Section on "Exterior Stone Cladding."]**

C. Stone Fabricators: Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available fabricators whose products may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names and possibly contact information for preapproved stone fabrication firms**>.

2.3 GRANITE **[STW-[##]]**

A. Material Standard: Comply with ASTM C 615/C 615M.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: Uniform, **[fine] [medium]-grained, [white] [pink] [gray] [black] <Insert color> stone[without veining]**.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

E. Cut: **[Vein] [Fleuri]**.

1. Orientation of Veining: **[Horizontal] [Vertical] [As indicated]**.

F. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

G. Finish: **[Polished] [Honed] [Thermal] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.4 LIMESTONE **[STW-[##]]**

A. Material Standard: Comply with ASTM C 568/C 568M.

1. Classification: **[II Medium] [III High]** Density.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: **[Dolomitic] [Oolitic] [Shell]** limestone.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

E. Cut: [Vein] [Fleuri].

1. Orientation of Veining: **[Horizontal] [Vertical] [As indicated]**.

F. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

G. Finish: **[Smooth] [Sand rubbed] [Machine tooled, four bats per 25 mm (1 inch)] [Machine tooled, six bats per 25 mm (1 inch)] [Machine tooled, eight bats per 25 mm (1 inch)] [As indicated] [Match Project Director/COR's sample] <Insert finish> [, matching standard ILI finish]**.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.5 MARBLE **[STW-[##]]**

A. Material Standard: Comply with ASTM C 503/C 503M**[, Classification I Calcite] [, Classification II Dolomite] [, Group A] [, Group B] [, Group C] [, Group D]**.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: Uniform, fine- to medium-grained, **[white] <Insert color>** stone with only slight veining.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. **<Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers>**.

E. Cut: **[Vein] [Fleuri]**.

1. Orientation of Veining: **[Horizontal] [Vertical] [As indicated]**.

F. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

G. Finish: **[Polished] [Honed] [As indicated] [Match Project Director/COR's sample]** <In**sert finish**>.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.6 QUARTZ-BASED STONE **[STW-[##]]**

A. Material Standard: Comply with ASTM C 616/C 616M **[Classification II Quartzitic Sandstone] [Classification III Quartzite] [, except for minimum free silica content]**.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Finish: **[Natural cleft] [Thermal] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

E. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.7 SERPENTINE **[STW-[##]]**

A. Material Standard: Comply with ASTM C 1526, **[Classification I Exterior] [Classification II Interior]**.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

E. Finish: **[Polished] [Honed] [As indicated] [Match Project Director/COR's sample] <Insert finish>**.

F. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.8 SLATE **[STW-[##]]**

A. Material Standard: Comply with ASTM C 629/C 629M, **[Classification I Exterior] [Classification II Interior]**.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Description: **[Black] [Blue-black] [Gray] [Blue-gray] [Green] [Purple] [Mottled purple and green] [Red]** slate with a fine, even grain[and unfading color,] from clear, sound stock.

D. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. **<Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers>**.

E. Finish: **[Honed] [Sand rubbed] [Natural cleft] [As indicated] [Match Project Director/COR's sample] <Insert finish>**.

F. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.9 TRAVERTINE **[STW-[##]]**

A. Material Standard: Comply with ASTM C 1527/C 1527M, **[Classification I Exterior] [Classification II Interior]**.

B. **[Regional Materials: Stone shall be fabricated within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered within 100 miles (160 km) of Project site.]**

C. Varieties and Sources: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available stone varieties that may be incorporated into the Work include, but are not limited to, the following]**:

1. <**Insert, in separate subparagraphs, names of varieties and producers, distributors, or importers**>.

D. Cut: **[Vein] [Fleuri]**.

1. Orientation of Veining: **[Horizontal] [Vertical] [As indicated]**.

E. Cut stone from one block or contiguous, matched blocks in which natural markings occur.

F. Filling: Fill pores on faces of stone with cementitious filler of color **[selected by Project Director/COR, based on input from the A/E of Record] [matching Project Director/COR's sample]**.

G. Finish: **[Polished] [Honed] [As indicated] [Match Project Director/COR's sample]** <**Insert finish**>.

H. Match Project Director/COR's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.10 SETTING MATERIALS

A. Molding Plaster: ASTM C 59/C 59M.

B. Portland Cement: ASTM C 150/C 150M, Type I or Type II.

1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

C. Hydrated Lime: ASTM C 207, Type S.

D. Aggregate: ASTM C 144.

E. Water: Potable.

2.11 GROUT

A. Grout Colors: **[Match stone] [As indicated by manufacturer's designations] [Match Project Director/COR's samples] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range]**.

B. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate to produce required color.

C. Standard Cement Grout: ANSI A118.6, packaged.

1. Grout Type: **[Sanded] [Unsanded]**.

D. High-Performance Tile Grout: ANSI A118.7, packaged.

1. Polymer Type: **[Acrylic resin] [or] [ethylene vinyl acetate]**, in dry, redispersible form, packaged with other dry ingredients.
2. Polymer Type: **[Acrylic resin] [or] [styrene-butadiene rubber]** in liquid-latex form for addition to packaged dry-grout mix.
3. Grout Type: **[Sanded] [Unsanded]**.

E. Water-Cleanable Epoxy Grout: ANSI A118.3, packaged, chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.

2.12 POINTING MORTAR MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or Type II. Provide natural color or white cement as required to produce mortar color indicated.

1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Pigments shall have a record of satisfactory performance in mortar.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime.

E. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Use a mix of formulation required to produce color indicated or, if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 10 percent of portland cement by weight.

F. Aggregate: ASTM C 144, except with 100 percent passing 1.18-mm (No. 16) sieve.

1. White Aggregates: Natural white sand or ground white stone.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.

G. Water: Potable.

2.13 SEALANTS

A. Joint Sealants: Manufacturer's standard sealants that comply with applicable requirements in Division 07 Section on "Joint Sealants" and will not stain the stone they are applied to.

1. Use mildew-resistant joint sealant at plumbing fixtures and for control and expansion joints in toilet rooms**[and other wet locations]**.
2. Colors: Provide colors of exposed sealants to match other joints in stone adjoining sealed joints unless otherwise indicated.

B. Sealant for Filling Kerfs: **[Same sealant used for joints in stone cladding.] [Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section on "Joint Sealants" and that do not stain stone:]**

1. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
2. Urethane, M, NS, 25, T, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

2.14 STONE ANCHORS AND ATTACHMENTS

A. Fabricate anchors from stainless steel, ASTM A 240/A 240M or ASTM A 666, Type 304.

1. Fasteners for Stainless-Steel Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 738M (ASTM F 593) for bolts and ASTM F 836M (ASTM F 594) for nuts, Alloy Group A1 (1).

B. Fabricate dowels from stainless steel, ASTM A 276, Type 304.

C. Fabricate anchors from extruded aluminum, ASTM B 221M (ASTM B 221), Alloy 6063-T6.

1. Fasteners for Extruded-Aluminum Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 738M (ASTM F 593) for bolts and ASTM F 836M (ASTM F 594) for nuts, Alloy Group A1 (1).

D. Anchor Support Grids: Roll-formed steel channels, of size and shape required for application indicated, formed from galvanized-steel sheet not less than 2.8 mm (0.108 inch) thick and complying with ASTM A 653/A 653M, Z275 (G90).

1. Fittings and Fasteners: System manufacturer's standard components of design, size, and material required to securely attach grids to building structure and stone anchors to grids. Fabricate components in contact with stone from same material specified for anchors.

E. Wire Tiebacks: **[No. 9 AWG copper or copper-alloy] [or] [3.0-mm- (0.120-inch-) diameter, stainless-steel]** wire.

F. Dovetail Slots: Furnish dovetail slots with filler strips of slot size required to receive anchors provided, fabricated from 0.86-mm- (0.034-inch-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, Z275 (G90).

G. Direct-Mount Anchoring Systems: Stainless-steel**[or aluminum]** stone anchors designed to be applied directly to wall surfaces**[or to metal grids]**. System is secured to wall framing, furring, or sheet-metal reinforcing strips built into wall with**[stainless-steel]** self-drilling screws. Anchors fit into kerfs or holes in edges of stone panels**[and do not need setting spots]**.

2.15 STONE ACCESSORIES

A. Temporary Setting Shims: Rigid plastic shims, nonstaining to stone, sized to suit joint thickness.

B. Setting Shims for Direct-Mount Anchoring Systems: Strips of resilient plastic or neoprene, nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.

C. Cleaner: Stone cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

D. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

1. Products shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.16 STONE FABRICATION, GENERAL

A. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.

1. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by Project Director/COR.

B. Fabricate stone paneling in sizes and shapes required to comply with requirements indicated.

1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
2. For marble, comply with recommendations in MIA's "Dimension Stone - Design Manual VII."
3. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."

C. Cut stone to produce pieces of thickness, size, and shape indicated and to comply with fabrication and construction tolerances recommended by applicable stone association.

1. Where items are installed with adhesive or where stone edges are visible in the finished work, make items uniform in thickness and of identical thickness for each type of item; gage back of stone if necessary.
2. Clean sawed backs of stones to remove rust stains and iron particles.
3. Dress joints straight and at right angle to face unless otherwise indicated.
4. Cut and drill sinkages and holes in stone for anchors, supports, and lifting devices as indicated or needed to set stone securely in place; shape beds to fit supports.
5. Provide openings, reveals, and similar features as needed to accommodate adjacent work.

D. Finish exposed faces and edges of stone to comply with requirements indicated for finish of each stone type required and to match approved Samples and sample installations.

E. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved Samples**[and sample installations]**.

2.17 STONE PANELING ON WALLS

A. Arrange panels in shop or other suitable space in proposed orientation and sequence for examination by Project Director/COR. Mark units with temporary sequence numbers to indicate position in proposed layout.

1. Lay out one elevation at a time if approved by Project Director/COR, based on input from the A/E of Record.
2. Notify Project Director/COR seven days in advance of date and time when layout will be available for viewing.
3. Provide lighting of similar type and level as that of final installation for viewing layout unless otherwise approved by Project Director/COR, based on input from the A/E of Record.
4. Rearrange panels as directed by Project Director/COR until layout is approved.
5. Do not trim nonmodular-size units to less than modular size until after Project Director/COR's approval of layout, unless otherwise approved by Project Director/COR, based on input from the A/E of Record.
6. Mark backs of units and Shop Drawings with sequence numbers based on approved layout. Mark backs of units to indicate orientation of units in completed Work.

B. Nominal Thickness: [**20 mm (3/4 inch)**] [**22 mm (7/8 inch)**] [**25 mm (1 inch)**] [**32 mm (1-1/4 inches)**] [**50 mm (2 inches)**] unless otherwise indicated.

C. Control depth of stone to maintain minimum clearances of **[20 mm (3/4 inch)] [25 mm (1 inch)]** between backs of panels and structural members, fireproofing if any, backup walls, and other work behind stone. Do not back check stone less than 25 mm (1 inch) thick.

D. Cut stone to produce uniform joints [**1.5 mm (1/16 inch)**] [**3 mm (1/8 inch)**] [**6 mm (1/4 inch)**] [**10 mm (3/8 inch)**] <**Insert dimension**> wide and in locations indicated.

E. Quirk-miter corners unless otherwise indicated. Fabricate for anchorage in top and bottom bed joints of corner units.

F. Pattern Arrangement: Fabricate and arrange panels with veining and other natural markings to comply with the following requirements:

1. Arrange panels with veining horizontal.
2. Arrange panels with veining vertical.
3. Arrange panels with veining as indicated on Drawings.
4. Arrange panels in blend pattern.

5. Book match units, single-course height.

6. Book match units, both vertically and horizontally.

7. Book match units in each course. No matching is required between successive courses.
8. Slip match units, single-course height.

9. Slip match units, both vertically and horizontally.

10. Slip match units in each course. No matching is required between successive courses.

2.18 CARVING AND INSCRIPTIONS

A. Carve and cut **[inscriptions] [and] [decorative surfaces]**. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.

B. Abrasively etch **[inscriptions] [and] [decorative surfaces]**.

C. Laser etch **[inscriptions] [and] [decorative surfaces]**.

2.19 MIXES

A. Spotting Plaster: Stiff mix of molding plaster and water.

B. Mortar, General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.

1. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated. Do not use calcium chloride.

2. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer unless otherwise indicated. Discard mortar when it has reached initial set.

C. Setting Mortar: Comply with ASTM C 270, Proportion Specification.

1. Type: **[Type N] [Type O]**.
2. Mix Proportions: 1 part portland cement and 2-1/2 to 4 parts lime with aggregate ratio of 2-1/4 to 3 times the volume of cement and lime.

D. Pointing Mortar: Comply with ASTM C 270, Proportion Specification, for mortar types indicated. Provide pointing mortar mixed to match Project Director/COR's sample and complying with the following:

1. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
2. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
3. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.
4. Type: **[Type N] [Type O]**.
5. Mix Proportions: 1 part portland cement and 2-1/2 to 4 parts lime with aggregate ratio of 2-1/4 to 3 times the volume of cement and lime.

E. Grout: Comply with mixing requirements of referenced ANSI standards and with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive stone paneling and conditions under which stone paneling will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone paneling.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone paneling.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING STONE, GENERAL

A. Before setting stone, clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight and true, with edges eased slightly to prevent snipping.

C. Contiguous Work: Provide reveals and openings as required to accommodate contiguous work.

D. Set stone to comply with requirements indicated. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.

E. Erect stone units level, plumb, and true with uniform joint widths. Use temporary shims to maintain joint width.

F. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.

1. Sealing of expansion and other joints is specified in Division 07 Section on "Joint Sealants."
2. Keep expansion joints free of plaster, mortar, grout, and other rigid materials.

3.3 CONSTRUCTION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces, do not exceed 3 mm in 2400 mm (1/8 inch in 96 inches), 6 mm (1/4 inch) maximum.

B. Variation from Level: For lintels, sills, chair rails, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 3 mm in 3 m (1/8 inch in 10 feet), 6 mm in 6 m (1/4 inch in 20 feet), 10 mm (3/8 inch) maximum.

C. Variation of Linear Building Line: For position shown in plan and related portion of walls and partitions, do not exceed 3 mm in 3 m (1/8 inch in 10 feet), 6 mm in 6 m (1/4 inch in 20 feet), 10 mm (3/8 inch) maximum.

D. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 3 mm (1/8 inch).

E. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1.5 mm (1/16 inch) or one-fourth of nominal joint width, whichever is less.

F. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 0.8-mm (1/32-inch) difference between planes of adjacent units.

3.4 INSTALLATION OF STONE FACING

A. Set units firmly against setting spots. Locate setting spots at anchors and spaced not more than 450 mm (18 inches) apart across back of unit, but provide no fewer than one setting spot per 0.18 sq. m (2 sq. ft.) unless otherwise indicated.

1. Moisture Exposure: Use portland cement mortar for setting spots where stone is applied to inside face of exterior walls and where indicated.

B. Set units with anchors securely attached to stone and to backup surfaces. Comply with anchoring recommendations in ASTM C 1242.

1. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant for filling kerfs.
2. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.

C. **[Minimum Anchors: Provide anchors at a maximum of 600 mm (24 inches) o.c. around perimeter of stone panels with a minimum of four anchors per panel.]**

D. **[Minimum Anchors: Provide a minimum of four anchors per panel up to 1.1 sq. m (12 sq. ft.) in face area, plus a minimum of two additional anchors for each additional 0.7 sq. m (8 sq. ft.).]**

E. **[Grout] [Point]** joints after setting stone.

F. Fill**[indicated]** joints with sealant after setting **[and grouting] [and pointing]** stone.

3.5 GROUTING JOINTS

A. Grout stone to comply with ANSI A108.10.

1. Use sanded grout mixture for joints wider than 3 mm (1/8 inch).
2. Use unsanded grout mixture for joints 3 mm (1/8 inch) and narrower.

B. Remove temporary shims before grouting.

C. Tool joints uniformly and smoothly with plastic tool.

3.6 POINTING JOINTS WITH MORTAR

A. Prepare stone-joint surfaces for pointing with mortar by removing temporary shims, dust, and mortar particles. Where setting spots occur at joints, rake out excess setting mortar or plaster to a depth of not less than 13 mm (1/2 inch).

B. Point stone joints by placing pointing mortar in layers of not more than 10 mm (3/8 inch). Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer. Apply mortar first to areas where depths are greater than surrounding areas until a uniform depth is formed.

C. Tool joints when pointing mortar is thumbprint hard. Use a round jointer having a diameter 3 mm (1/8 inch) larger than width of joint.

3.7 JOINT-SEALANT INSTALLATION

A. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Division 07 Section on "Joint Sealants." Remove temporary shims before applying sealants.

3.8 ADJUSTING AND CLEANING

A. In-Progress Cleaning: Clean stone paneling as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.

B. Remove and replace stone paneling of the following description:

1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Project Director/COR.
2. Defective stone paneling.
3. Defective joints, including misaligned joints.
4. Stone paneling and joints not matching approved Samples and sample installations.
5. Stone paneling not complying with other requirements indicated.

C. Replace in a manner that results in stone paneling that matches approved Samples and sample installations, complies with other requirements, and shows no evidence of replacement.

D. Clean stone paneling no fewer than six days after completion of grouting and pointing, using clean water and soft rags or stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.

E. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions and recommendations.

3.9 PROTECTION

A. Protect stone surfaces, edges, and corners from construction damage. Use securely fastened untreated wood, plywood, or heavy cardboard to prevent damage.

B. Before inspection for Substantial Completion, remove protective coverings and clean surfaces.

END OF SECTION 097513

SECTION 098433 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:

1. Sound-absorbing wall panels.

B. Material Index / Material Codes Include:

1. APW-[##] <(SOUND-ABSORBING) ACOUSTICAL PANEL WALL UNITS.>
2. FBG-[##] <*FABRIC*.>

C. Related Requirements:

1. Division 09 Section on "Wall Coverings" for adhesively applied textile wall coverings**[and for coordinated requirements for fabric]**.

1.2 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound Absorption Average.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For materials manufactured within 100 miles (160 km) of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.
3. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
4. Chain-of-Custody Qualification Data: For manufacturer and vendor.

5. Product Data: For adhesives, indicating VOC content.
6. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
8. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For unit assembly and installation.

1. Include plans, elevations, sections, and mounting devices and details.
2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
3. Include details at cutouts and penetrations for other work.
4. Include direction of fabric weave and pattern matching.

D. Samples for Verification: For the following products:

1. Fabric: Full-width by approximately 900-mm- long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Panel Edge: 300-mm- long Sample(s) showing each edge profile, corner, and finish.
3. Core Material: 300-mm- square Sample at corner.
4. Mounting Devices: Full-size Samples.
5. Assembled Panels: Approximately 900 by 900 mm, including joints and mounting methods.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by units including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Sprinklers.
f. Access panels.

3. Show operation of hinged and sliding components covered by or adjacent to units.

B. Product Certificates: For each type of unit.

C. Sample Warranty: For manufacturer's standard warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 9 sq. m, full width of bolt.
2. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

C. Mockups: Build mockup to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials, fabrication, and installation.

1. Build mockup of typical wall area **[as shown on Drawings] [1200 mm wide by full height] <Insert dimensions>.[Include intersection of wall and ceiling, corners, and perimeters.]**
2. Approval of mockup does not constitute approval of deviations from the Contract Documents contained in mockup unless Project Director/COR, based on input from the A/E of Record, specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockup may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install units until **[a permanent level of lighting] [a lighting level of not less than 538 lx]** <**Insert requirement**> is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.11 WARRANTY

A. Provide Manufacturer’s standard warranty.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain wall units specified in this Section from single source from single manufacturer.

B. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.2 SOUND-ABSORBING WALL UNITS

A. Sound-Absorbing Wall Panel **[APW-[##]]**: Manufacturer's standard panel construction consisting of facing material **[laminated to front face, edges, and back edge border of core] [stretched over front face of edge-framed core and bonded or attached to edges and back of frame]**.

1. Panel Shape: **[Flat] [As indicated on Drawings] <Insert shape>**.

2. Mounting: Edge mounted with splines secured to substrate.

a. Finish Color at Exposed Edges: **[White] [Black] [Match color of facing material] [Match Project Director/COR's sample] [As selected by Project Director/COR based on input from the A/E of Record from manufacturer's full range] <Insert requirement>**.

3. Mounting: Back mounted with manufacturer's standard **[adhesive] [adhesive tape strips] [hook-and-loop strips] [impaling clips] [magnetic devices] [metal clips or bar hangers]**, secured to substrate.

4. Core: **[Manufacturer's standard] [Glass-fiber board] [Mineral-fiber board] [Cementitious-fiber board] <Insert requirement>.[Provide wood or plywood nailing strips in core where indicated.]**

a. Core-Face Layer: Manufacturer's standard **[tackable, impact-resistant, high-density board] [impact-resistant, acoustically transparent, copolymer sheet] <Insert requirement>**.

5. Edge Construction: Manufacturer's standard **[chemically hardened core with no frame] [extruded-aluminum or zinc-coated, rolled-steel frame] [extruded PVC frame] [wood**

frame, rabbeted, and splined with glued joints and machined corners] <Insert requirement>.

6. Edge Profile: **[Long edges kerfed and rabbeted to receive splines] [Chamfered (beveled)] [Eased (small radius)] [Mitered (beveled to a point)] [Radiused (bullnosed)] [Square] [Custom profile as indicated on Drawings] <Insert profile>**.
7. Corner Detail in Elevation: **[Square] [Round, radius as indicated on Drawings] [Custom as indicated on Drawings] <Insert description>** with continuous edge profile indicated.
8. Reveals between Panels: **[Recessed] [Flush] [Projecting] reveals [as selected by Project Director/COR from manufacturer's full range] [as indicated on Drawings] <Insert requirement>**.
9. Facing Material: **[Project Director/COR-furnished material] [As indicated on Drawings] <Insert drawing designation>**.

10. Acoustical Performance: Sound absorption **[NRC] [or] [SAA] of [0.50 to 0.90] [0.60 to 0.70] [0.65 to 0.75] [not less than 0.65] <Insert range or single value>** according to ASTM C 423 for **[Type A] <Insert type>** mounting according to ASTM E 795.
11. Nominal Thickness: **[19mm] [As indicated on Drawings] <Insert dimension>**.
12. Panel Width: **[610 mm] [762 mm] [1220 mm] [As indicated on Drawings] <Insert dimension>**.
13. Panel Height: **[1829 mm] [2438 mm] [2743 mm] [3048 mm] [As indicated on Drawings] <Insert dimension>**.

2.3 MATERIALS

A. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert value>** percent.

C. Regional Materials: Products shall be manufactured within 100 miles (160 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.

D. Certified Wood: Wood products shall be certified as "FSC Pure"**[or "FSC Mixed Credit"]** according to FSC STD-01-001 and FSC STD-40-004.

E. Core Materials:**[Manufacturer's standard.]**

1. Glass-Fiber Board: ASTM C 612; of type standard with manufacturer; nominal density of **[96 to 112 kg/cu. m]** <**Insert value**>, unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of **[208 kg/cu. m] [320 kg/cu. m]**, and with perforated surface.

3. Tackable, Impact-Resistant, High-Density Board for Face Layer: 3.2-mm- thick layer of compressed molded glass-fiber board with a nominal density of 256 to 288 kg/cu. m laminated to face of core.

4. Impact-Resistant, Acoustically Transparent, Copolymer Sheet for Face Layer: 1.6- to 3.2-mm- thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.

5. Wood and Plywood: Manufacturer's standard plywood or clear, vertical grain, straight, kiln-dried hardwood.

   a. Fire-retardant treated by pressure process with a flame-spread index of 25 or less when tested according to ASTM E 84 or UL 723, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 3.2 m beyond the centerline of the burners at any time during the test.

      1) Treated material shall have a moisture content of 28 percent or less when tested according to ASTM D 3201/D 3201M at 92 percent relative humidity.
      2) Kiln-dry material after treatment to 19 percent or less for lumber and 15 percent or less for plywood.

F. Facing Material **[FBG-[##]]**: Fabric from same dye lot; color and pattern **[as indicated by manufacturer's designations] [matching Project Director/COR's samples] [as selected by Project Director/COR based on input from the A/E of Record from manufacturer's full range] [as indicated on Drawings]** <**Insert requirement**>.

1. Manufacturer: <**Insert manufacturer's name**>.
2. Product Line/Pattern: <**Insert product name or designation**>.
3. Pattern Repeat: <**Insert requirement**>.
4. Style Number: <**Insert number**>.
5. Color: <**Insert name or number, or both**>.
6. Fiber Content: **[100]** <**Insert number**> percent **[woven polyester] [nonwoven polyester] [polyolefin] [acoustically transparent vinyl]** <**Insert fiber requirement**>.
7. Width: **[1371 mm] [1676 mm]** <**Insert dimension**>.
8. Source: <**Insert fabric-vendor's name**>.

9. Applied Treatments: **[Stain resistance] [and] [flame retardant]** <**Insert treatment**>.

G. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

1. Splines: Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the unit, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.

2. Adhesives shall have a VOC content of **[70]** <**Insert value**> g/L or less.

3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Adhesive Tape Strips: **[Manufacturer's standard 1.6-mm- thick, double-sided foam tape]** <**Insert requirement**>.
5. Hook-and-Loop Strips: **[Manufacturer's standard]** <Insert requirement>.
6. Impaling Clips: **[Manufacturer's standard]** <Insert requirement>.
7. Magnetic Strip or Devices: **[Manufacturer's standard]** <Insert requirement>.
8. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.4 FABRICATION

A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Edge Hardening: For **[glass-fiber board] [and] [mineral-fiber board]** cores, chemically harden core edges and areas of core where mounting devices are attached.

C. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

D. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.**[Heat-seal vinyl fabric seams at corners.]**
2. Radius and Other Nonsquare Corners: Attach facing material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

E. Dimensional Tolerances of Finished Units: Plus or minus 1.6 mm for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

C. Align fabric pattern and grain **[with adjacent units] [as indicated on Drawings]**.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus **[1.6 mm]** <**Insert dimension**> in 1200 mm, noncumulative.

B. Variation of Joint Width: Not more than **[1.6-mm] [0.79-mm]** <**Insert dimension**> variation from **[hairline] [reveal line]** in 1200 mm, noncumulative.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 098433

SECTION 099601 - HIGH-PERFORMANCE COATINGS FOR GENERAL USAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes surface preparation and field application of high-performance coating systems to items and surfaces scheduled.

B. Related Requirements:

1. Other Division 09 Section(s) for general interior and exterior field painting.
2. Division 09 Section on “High-Performance FE/BR Coatings.”

1.2 DEFINITIONS

A. MPI Gloss Level according to ASTM D523

1. Level 5: 35 to 70 units at 60 degree meter; “semigloss.”
2. Level 6: 70 to 85 units at 60 degree meter; “gloss.”
3. Level 7: More than 85 units at 60 degree meter; “high-gloss.”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 200 mm square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

E. LEED Submittals: For Credit EQ 4.2, manufacturers' product data for coatings, including printed statement of VOC content and chemical components.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.

B. Storage:

1. Store materials not in use in tightly covered containers.
2. Store materials in a well-ventilated area at a minimum ambient temperature of 7 deg C. {max temp & humidity?}
3. Keep storage area neat and orderly. Take necessary measures to ensure that workers and storage areas are protected from fire and health hazards resulting from handling and mixing coatings.
4. Maintain unused and used containers in clean condition, free of foreign materials and residue.
5. Remove rags and waste from storage areas daily.

C. Handling:

1. Store materials when not in use and return them to storage areas when project conditions are outside of the permissible temperature range for application.
2. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling and applying coatings.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between temperatures recommended by coating manufacturers, but in no case lower than 10 deg C or higher than 35 deg C.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 3 deg C above the dew point; or to damp or wet surfaces.

1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods, and only if work in those conditions is in accordance with manufacturer’s recommendations.

1.7 MAINTENANCE MATERIALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 4 L (1 gal.) of each material and color applied.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

C. <Insert sustainable design text for coatings.> < VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 450 g/L or less.>

D. Colors: **[As selected by Architect from manufacturer's full range] [Match Architect's samples] [As indicated in color schedule] <Insert requirements>**.

2.2 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Government reserves the right to invoke the following procedure:

1. Government may engage services of qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency testing will be to verify compliance with product requirements

PART 3 - EXECUTION

3.1 EXAMINATION

A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. [Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Fiber-Cement Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.
4. Wood: 15 percent.
5. Gypsum Board: 12 percent.
6. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.]

E. [Verify suitability of substrates (including surface conditions and compatibility) with existing finishes.]

F. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

a. Confirmation of primer's suitability for expected service conditions.
b. Confirmation of primer's ability to be top coated with materials specified.

2. Notify Project Director/COR about anticipated problems before using the coatings specified over substrates primed by others.

G. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

D. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

E. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers, or apply tie coat as required to produce coating systems indicated.

F. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces.

G. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of 10,000 to 25,000 kPa (1500 to 4000 psi) at 150 to 300 mm (.
2. Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4.

H. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer**.** but not less than the following:

1. [SSPC-SP 11.]

2. [SSPC-SP 6/NACE No. 3.]

3. [SSPC-SP 10/NACE No. 2.]

4. [SSPC-SP 5/NACE No. 1.]

I. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

J. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

K. Aluminum Substrates: Remove loose surface oxidation.

L. [Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of (700 to 4000 kPa) (100 to 600 psi) at 150 to 300 mm (6 to 12 inches).]

M. [Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer that is recommended in writing by topcoat manufacturer for coating system indicated.
2. Sand surfaces that will be exposed to view and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with filler that is recommended in writing by topcoat manufacturer for coating system indicated. Sand smooth when dried.]

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques best suited for the material being applied.
2. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.

B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

D. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required is the same regardless of application method.

a. Omit primer on metal surfaces that have been shop primed and touchup painted.
b. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
c. Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.
d. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until coating has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause undercoat to lift or lose adhesion.

E. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
b. Brush out and work brush coats into surfaces in an even film.
c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.

3. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations, to include application in occupied buildings.

   a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
   b. Apply each coat to provide the equivalent hiding of brush-applied coats.
   c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

F. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

G. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

H. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

   1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

I. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.4 FIELD QUALITY CONTROL

A. Material Testing: Government reserves the right to engage the services of a qualified testing agency to sample coating material being used. When this right is invokes, samples of material delivered to Project site shall be taken, identified, sealed, and certified in presence of Project Director/COR.

   1. Testing agency will perform appropriate tests for the following characteristics as required by Government:

      a. Quantitative materials analysis.
      b. Absorption.
      c. Accelerated weathering.
      d. Accelerated yellowness.
      e. Color retention.
      f. Alkali and mildew resistance.
      g. Abrasion resistance.
      h. Apparent reflectivity.
      i. Washability.
      j. Dry opacity.

k. Recoating.
l. Skinning.

B. Dry Film Thickness Testing: Government reserves the right to engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.

C. Corrective Actions:

1. Failure of Materials Compliance:

a. Government may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

2. Failure of Dry Film Thickness Compliance:

a. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Project Director/COR, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.

D. Dispose of used containers in accordance with requirements of local jurisdiction.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Vertical Surfaces:

1. Epoxy System **[MPI EXT 3.1D]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy-Modified Latex System **[MPI EXT 3.1E]**:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

3. Pigmented Polyurethane over Epoxy System [**MPI EXT 3.1M**]:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

B. Concrete Substrates, Horizontal Surfaces:

1. Epoxy Non-Slip Deck Coating System **[MPI EXT 3.2C]**:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Epoxy deck coating (slip resistant)**[, MPI #82]**.

C. Cement Board Substrates:

1. Epoxy System **[MPI EXT 3.3E]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy-Modified Latex System **[MPI EXT 3.3D]**

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

3. Pigmented Polyurethane over Epoxy System **[MPI EXT 3.3F]**:

   a. Prime Coat: Epoxy, gloss**[, MPI #77]**.
   b. Intermediate Coat: Epoxy, matching prime coat.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

D. Clay Masonry Substrates:

1. Epoxy System **[MPI EXT 4.1D]**:

   a. Prime Coat: Epoxy, matching topcoat.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane over Epoxy System **[MPI EXT 4.1J]**:

   a. Prime Coat: Epoxy, matching intermediate coat.
   b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

E. CMU Substrates:

1. Epoxy System **[MPI EXT 4.2E]**:

   a. Block Filler: Block filler, epoxy**[, MPI #116]**.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane over High-Build Epoxy System [**MPI EXT 4.2G**]:

   a. Block Filler: Block filler, epoxy**[, MPI #116]**.
   b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

F. Steel Substrates:

1. Epoxy System **[MPI EXT 5.1F]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy over Self-Priming Epoxy System **[MPI EXT 5.1S]**:

   a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
   b. Intermediate Coat: Epoxy, matching topcoat.

c. Topcoat: Epoxy, gloss**[, MPI #77]**.

3. Epoxy Deck Coating over Epoxy Primer and High-Build Epoxy System **[MPI EXT 5.1V]**:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.
c. Topcoat: Epoxy deck coating**[, MPI #82]**.

4. Epoxy Deck Coating over Self-Priming Epoxy System **[MPI EXT 5.1X]**:

a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
b. Topcoat: Epoxy deck coating**[, MPI #82]**.

5. Pigmented Polyurethane over Epoxy System **[MPI EXT 5.1H]**:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

6. Pigmented Polyurethane over High-Build Epoxy System **[MPI EXT 5.1J]**:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

7. Pigmented Polyurethane over Self-Priming Epoxy System **[MPI EXT 5.1T]**:

a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

8. Pigmented Polyurethane over Epoxy Zinc-Rich Primer System **[MPI EXT 5.1P]**:

a. Prime Coat: Primer, zinc rich, epoxy**[, MPI #20]**.
b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

9. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and High-Build Epoxy System **[MPI EXT 5.1G]**:

a. Prime Coat: Primer, zinc rich, epoxy**[, MPI #20]**.
b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.
c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

10. Pigmented Polyurethane over Inorganic Zinc-Rich Primer and High-Build Epoxy System **[MPI EXT 5.1L]**:

    a. Prime Coat: Primer, zinc rich, inorganic**[, MPI #19]**.
    b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.
    c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

G. Galvanized-Metal Substrates:

1. Epoxy System **[MPI EXT 5.3C]**:

    a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane over Epoxy Primer System **[MPI EXT 5.3L]**:

    a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
    b. Intermediate Coat: Polyurethane, two component, pigmented, gloss matching topcoat.
    c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

H. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Epoxy System **[MPI EXT 5.4E]**:

    a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane over Epoxy System **[MPI EXT 5.4B]**:

    a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
    b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
    c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

I. Copper Substrates:

1. Epoxy System **[MPI EXT 5.5E]**:

    a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
    b. Intermediate Coat: Epoxy, matching topcoat.
    c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane over Epoxy System **[MPI EXT 5.5B]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

J. Stainless-Steel Substrates:

1. Epoxy System **[MPI EXT 5.6D]**:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

K. Wood Substrates: Glued-laminated construction.

1. Pigmented Polyurethane System **[MPI EXT 6.1J]**:

a. Prime Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

L. Wood Substrates: Exposed framing.

1. Pigmented Polyurethane System **[MPI EXT 6.2J]**:

a. Prime Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

M. Wood Substrates: **[Wood trim] [Architectural woodwork] [Doors] [Windows] [Wood board siding] [and] [wood fences]**

1. Pigmented Polyurethane System **[MPI EXT 6.3H]**:

a. Prime Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

N. Fiberglass Substrates:

1. Epoxy System **[MPI EXT 6.7F]**:

a. Prime Coat: Epoxy, matching topcoat.

b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**

2. Epoxy-Modified Latex System **[MPI EXT 6.7E]**

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

3. Pigmented Polyurethane over Epoxy System **[MPI EXT 6.7D]**:

a. Prime Coat: Epoxy, matching intermediate coat.
b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

O. Portland Cement Plaster Substrates:

1. Epoxy System **[MPI EXT 9.1D]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

3.7 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Vertical Surfaces:

1. Epoxy System **[MPI INT 3.1F]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy, High-Build System **[MPI INT 3.1P]**:

a. Prime Coat: High-build epoxy, matching topcoat (reduced).
b. Intermediate Coat: High-build epoxy, matching topcoat.

c. [Topcoat: High-build epoxy, low gloss[, MPI #108].]
d. [Topcoat: High-build epoxy, gloss[, MPI #98].]

3. Epoxy-Modified Latex System **[MPI INT 3.1G]**:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

B. Concrete Substrates, Horizontal Surfaces.

1. Epoxy System **[MPI INT 3.2C]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.
d. Additive: Non-skid (Facility Management Shop locations only).

2. Epoxy, High-Build System **[MPI INT 3.2L]**:

a. Prime Coat: High-build epoxy, matching topcoat (reduced).
b. Intermediate Coat: High-build epoxy, matching topcoat.

c. [Topcoat: High-build epoxy, low gloss[, MPI #108].]
d. [Topcoat: High-build epoxy, gloss[, MPI #98].]

3. Pigmented Polyurethane System **[MPI INT 3.2D]**:

a. Prime Coat: Epoxy, gloss**[, MPI #77]**.
b. Intermediate Coat: Polyurethane, two component, pigmented, gloss, matching topcoat.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

4. Clear (Two-Component) Polyurethane System **[MPI INT 3.2K]**:

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component (MPI Gloss Level 6 or MPI Gloss Level 7)**[, MPI #78]**.

C. Cement Board Substrates:

1. Epoxy System **[MPI INT 3.3E]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy-Modified Latex System **[MPI INT 3.3D]**:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]

d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

D. Clay Masonry Substrates:

1. Epoxy System **[MPI INT 4.1F]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy-Modified Latex System **[MPI INT 4.1G]**:

a. Prime Coat: Epoxy-modified latex, matching topcoat.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

3. Clear (Two-Component) Polyurethane System [**MPI INT 4.1K**]:

a. Prime Coat: Two-component polyurethane, matching topcoat.
b. Intermediate Coat: Two-component polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component (MPI Gloss Level 6 or MPI Gloss Level 7)**[, MPI #78]**.

E. CMU Substrates:

1. Epoxy System **[MPI INT 4.2F] [MPI INT 4.2G]**:

a. [Block Filler: Block filler, latex, interior/exterior[, MPI #4].]
b. [Block Filler: Block filler, epoxy[, MPI #116].]
c. Intermediate Coat: Epoxy, matching topcoat.
d. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy, High-Build System **[MPI INT 4.2R]**:

a. Prime Coat: Epoxy block filler**[, MPI #116]**.
b. Intermediate Coat: High-build epoxy, matching topcoat.

c. [Topcoat: High-build epoxy, low gloss[, MPI #108].]
d. [Topcoat: High-build epoxy, gloss[, MPI #98].]

3. Epoxy-Modified Latex System **[MPI INT 4.2J]**:

a. Block Filler: Block filler, latex, interior/exterior**[, MPI #4]**.
b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

4. Clear (Two-Component) Polyurethane System **[MPI INT 4.2Q]**:

   a. Prime Coat: Two-component polyurethane, matching topcoat.
   b. Intermediate Coat: Two-component polyurethane, matching topcoat.
   c. Topcoat: Varnish, aliphatic polyurethane, two component (MPI Gloss Level 6 or MPI Gloss Level 7)**[, MPI #78]**.

F. Steel Substrates:

1. Epoxy System **[MPI INT 5.1L]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. High-Build Epoxy over Epoxy Zinc-Rich Primer System **[MPI INT 5.1P]**:

   a. Prime Coat: Primer, zinc-rich, epoxy**[, MPI #20]**.
   b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.

   c. [Topcoat: Epoxy, gloss[, MPI #77].]
   d. [Topcoat: Epoxy, high-build, low gloss[, MPI #108].]

3. Epoxy over Self-Priming Epoxy System **[MPI INT 5.1V]**:

   a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

4. Epoxy, High-Build System **[MPI INT 5.1Y]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: High-build epoxy, matching topcoat.

   c. [Topcoat: High-build epoxy, low gloss[, MPI #108].]
   d. [Topcoat: High-build epoxy, gloss[, MPI #98].]

5. Epoxy Deck Coating System **[MPI INT 5.1LL]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
   c. Topcoat: Epoxy deck coating (slip resistant)**[, MPI #82]**.

6. Epoxy-Modified Latex System **[MPI INT 5.1K]**:

   a. Prime Coat: Primer, rust inhibitive, water based**[, MPI #107]**.
   b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.

   c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]

d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

7. Pigmented Polyurethane over Epoxy Primer System **[MPI INT 5.1F]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

8. Pigmented Polyurethane over High-Build Epoxy System **[MPI INT 5.1G]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Epoxy, high build**[, MPI #108]**.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

9. Pigmented Polyurethane over Self-Priming Epoxy System **[MPI INT 5.1U]**:

   a. Prime Coat: Epoxy, high build, self-priming **[, MPI #120]**.
   b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

10. Pigmented Polyurethane over Inorganic Zinc and Epoxy System **[MPI INT 5.1H]**:

    a. Prime Coat: Primer, zinc rich, inorganic**[, MPI #19]**.
    b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
    c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

11. Pigmented Polyurethane over Epoxy Zinc-Rich and Epoxy System **[MPI INT 5.1J]**:

    a. Prime Coat: Primer, zinc rich, epoxy**[, MPI #20]**.
    b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
    c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

G. Galvanized-Metal Substrates:

1. Epoxy over Epoxy Primer System **[MPI INT 5.3D]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

H. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Epoxy System **[MPI INT 5.4B]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane System **[MPI INT 5.4C]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
c. Topcoat: Polyurethane, two-component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

I. Copper Substrates:

1. Epoxy System **[MPI INT 5.5B]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane System **[MPI INT 5.5C]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

J. Stainless-Steel Substrates:

1. Epoxy System **[MPI INT 5.6C]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane System **[MPI INT 5.6D]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

K. Wood Substrates: Glued-laminated construction.

1. Epoxy System **[MPI INT 6.1L]**:

a. Prime Coat: Epoxy, matching topcoat.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane System **[MPI INT 6.1E]**:

   a. Prime Coat: Polyurethane, two component, pigmented, matching topcoat.
   b. Intermediate Coat: Polyurethane, two component, pigmented, matching topcoat.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

L. Wood Substrates: **[Wood trim] [Architectural woodwork] [Doors] [Windows] [and] [wood board paneling]**.

1. Epoxy System **[MPI INT 6.3L]**:

   a. Prime Coat: Epoxy, matching topcoat.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

M. Fiberglass Substrates:

1. Epoxy System **[MPI INT 6.7D]**:

   a. Prime Coat: Epoxy, matching topcoat.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Pigmented Polyurethane System **[MPI INT 6.7E]**:

   a. Prime Coat: Epoxy, gloss**[, MPI #77]**.
   b. Intermediate Coat: Epoxy, matching prime coat.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

3. Epoxy-Modified Latex System **[MPI INT 6.7F]**:

   a. Block Filler: Block filler, latex, interior/exterior**[, MPI #4]**.
   b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.

   c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
   d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

N. **[Gypsum Board] [Plaster]** Substrates:

1. Epoxy System **[MPI INT 9.2E]**:

   a. Prime Coat: Primer sealer, latex, interior**[, MPI #50]**.
   b. Intermediate Coat: Epoxy, matching topcoat.
   c. Topcoat: Epoxy, gloss**[, MPI #77]**.

2. Epoxy, High-Build System **[MPI INT 9.2N]**:

a. Prime Coat: Primer sealer, latex, interior**[, MPI #50]**.
b. Intermediate Coat: High-build epoxy, matching topcoat.

c. [Topcoat: High-build epoxy, low gloss[, MPI #108].]
d. [Topcoat: High-build epoxy, gloss[, MPI #98].]

3. Epoxy-Modified Latex System **[MPI INT 9.2F]**:

a. Prime Coat: Primer sealer, latex, interior**[, MPI #50]**.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.

c. [Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5)[, MPI #215].]
d. [Topcoat: Epoxy-modified latex, gloss (MPI Gloss Level 6)[, MPI #115].]

END OF SECTION 099601

SECTION 099602 – HIGH-PERFORMANCE FE/BR COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems on assemblies identified below under "Related Requirements."

1. Unless otherwise noted for specific coating applications, coatings shall be applied in an Applicator's shop apart from field touch-up.

B. Related Requirements:

1. Section 077234, "Forced Entry (FE) / Ballistic Resistant (BR) Roof Hatches."
2. **[Various Division 08 Sections address the requirements for anodized coatings.]**
3. Section 083454, "Forced Entry (FE) / Ballistic Resistant (BR) Door Assemblies."
4. Section 083322, "Overhead Forced-Entry (FE) Coiling Doors."
5. **[Section 084414, "Structurally-Framed Security Curtain Wall System."]**
6. Section 085651, "Aluminum Security Windows."
7. Section 085652, "Aluminum Security Teller Windows."
8. Section 089117, "Security Louvers."
9. Section 099601, "High-Performance Coatings for General Usage" for coatings not associated with FE/BR assemblies.

1.2 DEFINITIONS

A. High-Performance Coating: In this Section the general use of "high-performance" is only intended to distinguish from standard painting systems. Some coatings in this Section may be identified by industry standards as having "Superior Performance."

B. MPI Gloss Level according to ASTM D523 as applicable; see Part 2 Article on EXTERIOR FE/BR COATING SCHEDULE.

1. Gloss Level 1 (Flat): Not more than 5 units at 60 degrees and 10 units at 85 degrees, in accordance with ASTM D523.
2. Gloss Level 2 (Low Sheen): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.
3. Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, in accordance with ASTM D523.
4. Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, in accordance with ASTM D523.
5. Gloss Level 5 (Semi-Gloss): 35 to 70 units at 60 degrees, in accordance with ASTM D523.
6. Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees, in accordance with ASTM D523.
7. Gloss Level 7 (High-Gloss): More than 85 units at 60 degrees, in accordance with ASTM D523.

1.3 REFERENCES

A. American Architectural Manufacturers Association (FGIA/AAMA):

1. FGIA/AAMA 621, “Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.”
2. FGIA/AAMA 643, ”Voluntary Specification, Performance Requirements and Test Procedures for Solar Reflectance Finishes.”
3. FGIA/AAMA 2605, “Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions.”

B. American Society for Testing and Materials (ASTM):

1. ASTM B 117, “Practice for Operating Salt Spray (Fog) Apparatus.”
2. ASTM D 16, “Standard Terminology for Paint, Related Coatings, Materials, and Applications.”
3. ASTM D 1654, “Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.”
4. ASTM D 2244, “Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.”
5. ASTM D 2247, “Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.”
6. ASTM D 3363, “Standard Test Method for Film Hardness by Pencil Test.”
7. ASTM D 4214, “Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.”
8. ASTM D 7091, “Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.”
9. ASTM E 1980, “Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.”
10. ASTM G 85 annex 5, “Modified Salt Spray Cyclic Fog Test.”

C. Steel Structures Painting Council (SSPC):

1. SSPC SP6, “Commercial Blast Cleaning Procedures.”
2. SSPC SP10, “Near White Blast Cleaning Procedure.”

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.
3. Material List: An inclusive list of required coating materials. Indicate each material and cross reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

4. Preparation instructions and recommendations.
5. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Initial Selection: For each type of topcoat product indicated. For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

C. [Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated. For each finish product specified, two samples, minimum size 200 mm square, representing actual product, color, and patterns.

1. Submit Samples on rigid backing, 200 mm square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.]

D. Product test reports.

E. Qualifications: For coatings Applicator.

F. Maintenance data.

G. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Fluoropolymer Coatings: Coating manufacturer’s approved certified applicator, equipped, trained and approved for application of coatings required for this Project, and is approved to provide warranty specified in this Section.
2. Other Coatings of this Section: Engage an experienced applicator who has completed high performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Paint exposed surfaces. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.

D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

E. [Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Project Director/COR will select one surface to represent surfaces and conditions for application of each scheduled coating system.

a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Project Director/COR will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Project Director with input from the Architect of Record at no added cost to the Government.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR, with input from the Architect of Record, specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.]

1.6 DELIVERY, STORAGE, AND HANDLING

A. For on-site work, deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number, date of manufacture and batch date.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.
9. VOC content.
10. Environmental handling requirements.
11. Surface preparation requirements.

B. On-Site Storage as applicable:

1. Store materials not in use in tightly covered containers.
2. Store materials in a well-ventilated area within the minimum and maximum ambient temperature and humidity recommended by the coating manufacturer.
3. Keep storage area neat and orderly. Take necessary measures to ensure that workers and storage areas are protected from fire and health hazards resulting from handling and mixing coatings.

4. Maintain unused and used containers in clean condition, free of foreign materials and residue.
5. Remove rags and waste from storage areas daily.

C. On-Site Handling as applicable:

1. Store materials when not in use and return them to storage areas when project conditions are outside of the permissible temperature range for application.
2. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling and applying coatings.

1.7 FIELD CONDITIONS

A. Conditions for work at an Applicator’s shop shall be in accordance with manufacturer’s recommendations.

B. Conditions for application in the field (as applicable) shall be in accordance with manufacturer’s recommendations; where those do not identify specific constraints conform to the following:

1. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
2. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between temperatures recommended by coating manufacturers, but in no case lower than 10 deg C or higher than 32 deg C.
3. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 7 and 35 deg C (45 and 95 deg F).
4. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 3 deg C above the dew point; or to damp or wet surfaces.

   a. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
   b. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods, and only if work in those conditions is in accordance with manufacturer’s recommendations.

1.8 MAINTENANCE MATERIALS

A. Furnish manufacturer recommended touch-up materials, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 4 L (1 gal.) of each material and color applied.

1.9 WARRANTY

A. Special Warranty: Coating Applicator's warranty in which Applicator agrees to repair finish or replace coated items that demonstrate deterioration of shop-applied finishes within warranty period indicated.

1. Failures include, but are not limited to, the following:

a. Exposed Coating: Deterioration includes but is not limited to:
b. Color fading in excess of 5 Delta E Hunter units per ASTM D 2244.
c. Peeling, checking or cracking of coating adhesion to metal.
d. Chalking in excess of a No. 8 per ASTM D 4214, when tested per Method D 659.
e. Corrosion of substrate in excess of a No. 6 on cut edges and a No. 8 on field surfaces, when measured per ASTM D 1654.

2. Warranty Period: 10 years from date of substantial completion.

PART 2 - PRODUCTS

2.1 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. MPI Standards: As applicable, products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

C. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

D. Color: Refer to Finish Schedule and Paint Legend for paint colors.

E. See Table, *HIGH-PERFORMANCE FE/BR COATING APPLICATIONS*, located after the end of this specification for specific application requirements for the different types of FE/BR products.

2.2 FLUOROPOLYMER COATINGS

A. Manufacturers:

1. Subject to compliance with requirements, provide products from one of the following manufacturers:

a. AkzoNobel.
b. PPG.
c. Sherwin -Williams.

2. Requests for products of other manufacturers conforming to the requirements of this Sections will be considered as substitutions in accordance with Division 01.

B. Fluoropolymer System for Aluminum Substrate: Where indicated, provide manufacturer's standard thermocured system with minimum of three coats, containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight, complying with AAMA 2605.

C. Fluoropolymer System for Steel Substrate: Where indicated, provide manufacturers' standard thermocured system, containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight, complying with AAMA 621.

D. Locations with Extreme Atmospheric Corrosivity Levels (ACL): Provide the manufacturer's recommended pretreatment and primer normally associated with severe environments.

1. Pretreatment: Chromium chromate or chromium phosphate coating weight range is required to be greater than 40 mg/ft2as measured by x-ray fluorescence (XRF) per ASTM D5723.
2. Primer: Liquid chromate primer under liquid and powder topcoats, or powder primer under powder topcoats.

E. [Clear Coat:

[DESIGNER-OF-RECORD SHALL EVALUATE INCLUSION OF THIS COAT. THE FIRST TWO FACTORS ARE STRAIGHTFORWARD; THE THIRD FACTOR INVOLVES JUDGMENT.]

1. Required over metallic flake coating, if that is used.
2. Required for locations with Extreme ACL.
3. [Use to improve chalk and fade resistance.]]

2.3 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: The Government reserves the right to invoke the following procedure:

1. The Government may engage services of qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency testing will verify compliance with product requirements

2.4 SHOP APPLICATION

A. Coating in Applicator's Shop: The substrates to receive these coatings shall be prepared and treated, and the assemblies coated all in accordance with the manufacturer's recommendations and applicable industry standards.

B. On-site shops are not acceptable.

1. [Exceptions: The following exceptions require the approval of the Project Director/COR with consultation from OBO subject matter experts.]

a. [On-site shops may be permitted for limited scale renovation work and for recoating work.]

2.5 EXTERIOR FE/BR COATING SCHEDULE

A. Steel Substrates (Ferrous Metal):

1. Pigmented Polyurethane System required for shop-fabricated exterior steel items:

   a. Prime Coat: Alkyd anti-corrosive, quick dry:
      S-W Pro-Cryl Universal Primer, B66-310 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.
   b. Intermediate Coat: Polyurethane, two-component, pigmented, matching topcoat.
   c. Topcoat: Polyurethane, two-component, pigmented, gloss:
      S-W Pro Industrial Waterbased Acrolon 100 Polyurethane, B65-720 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.

2. Pigmented Polyurethane over Epoxy System if commercial blast cleaning of steel substrate is not practical **[MPI EXT 5.1H]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
      S-W Macropoxy 646-100, B58-600 Series, at 5.0 to 10 mils (0.127 to 0.254 mm) dry, per coat.
   b. Intermediate Coat: Epoxy, gloss**[, MPI #77]**.
      Polyurethane, two-component, pigmented, matching topcoat.
   c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.
      S-W Pro Industrial Waterbased Acrolon 100 Polyurethane, B65-720 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.

3. Pigmented Polyurethane over Epoxy Zinc-Rich Primer System is useful for application to non-galvanized steel items that will be in wet or corrosive environments – typically applied in fabrication shop over properly-prepared steel**. [MPI EXT 5.1P]**:

   a. Prime Coat: Primer, zinc rich, epoxy**[, MPI #20]**.
      S-W Zinc Clad III HS 100, at 3.0 to 5.0 mils (0.076 to 0.127 mm) dry, per coat.

b. Intermediate Coat: Epoxy, low gloss**[, MPI #77]**.
S-W Macropoxy 646-100, B58-600 Series, at 5.0 to 10 mils (0.127 to 0.254 mm) dry, per coat.
c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.
S-W Pro Industrial Waterbased Acrolon 100 Polyurethane, B65-720 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.

4. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and Epoxy System **[MPI EXT 5.1G]**:

a. Prime Coat: Primer, zinc rich, epoxy**[, MPI #20]**.
b. Intermediate Coat: Epoxy, high build, low gloss**[, MPI #108]**.
c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.

5. Urethane System solvent base, Semi-Gloss Finish:

a. 1st Coat: S-W Macropoxy 646-100 Fast Cure Epoxy, B58 Series (7.0-13.5 mils wet, 5.0-10.0 mils dry per coat).
b. 2nd Coat: S-W Hi-Solids Polyurethane Semi-Gloss, B65-350 Series.
c. 3rd Coat: S-W Hi-Solids Polyurethane Semi-Gloss, B65-350 Series. (4.5-8.0 mils wet, 3.0-5.0 mils dry per coat).

6. Fluoropolymer System: See the Part 2 Article on FLUOROPOLYMER COATINGS.

B. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Pigmented Polyurethane over Epoxy System **[MPI EXT 5.4B]**:

a. Prime Coat: Primer, vinyl wash**[, MPI #80]**.
S-W DTM Wash Primer, at 0.2 to 0.4 mils (0.005 to 0.010 mm) dry, per coat.
b. Intermediate Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
c. First and Second Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72]**.
S-W Pro Industrial Waterbased Acrolon 100 Polyurethane, B65-720 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.

2. Urethane Systems, solvent base, Gloss Finish:

a. 1st Coat: S-W DTM Wash Primer, B71Y1 (3.4-6.4 mils wet, 0.7-1.3 mils dry).
b. 2nd Coat: S-W Hi-Solids Polyurethane Gloss, B65/B60-30 Series.
c. 3rd Coat: S-W Hi-Solids Polyurethane Gloss, B65/B60-30 Series (4.5-8.0 mils wet, 3.0-5.0 mils dry per coat).

3. Fluoropolymer System: See the Part 2 Article on FLUOROPOLYMER COATINGS.

C. Galvanized-Metal Substrates: If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.

1. Pigmented Polyurethane over Epoxy Primer System **[MPI EXT 5.3L]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Polyurethane, two component, pigmented, gloss matching topcoat.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72].**

2. Pigmented Polyurethane over Vinyl Wash Primer System:

   a. Prime Coat: Primer, vinyl wash at 0.7 to 1.3 mils (0.018 to 0.033 mm) dry, per coat.
   b. First and Second Topcoat: Polyurethane, two-component, pigmented, gloss: S-W Pro Industrial Waterbased Acrolon 100 Polyurethane, B65-720 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.

3. Urethane Systems, solvent base, Gloss Finish:

   a. 1st Coat: S-W DTM Wash Primer, B71Y1 (3.4-6.4 mils wet, 0.7-1.3 mils dry).
   b. 2nd Coat: S-W Hi-Solids Polyurethane Gloss, B65/B60-30 Series.
   c. 3rd Coat: S-W Hi-Solids Polyurethane Gloss, B65/B60-30 Series (4.5-8.0 mils wet, 3.0-5.0 mils dry per coat).

4. Fluoropolymer System: See the Part 2 Article on FLUOROPOLYMER COATINGS.

D. Stainless Steel Substrates:

1. Pigmented Polyurethane over Epoxy Primer System **[MPI EXT 5.3L]**:

   a. Prime Coat: Primer, epoxy, anti-corrosive, for metal**[, MPI #101]**.
   b. Intermediate Coat: Polyurethane, two component, pigmented, gloss matching topcoat.
   c. Topcoat: Polyurethane, two component, pigmented, gloss (MPI Gloss Level 6)**[, MPI #72].**

2. Pigmented Polyurethane over Vinyl Wash Primer System:

   a. Prime Coat: Primer, vinyl wash at 0.7 to 1.3 mils (0.018 to 0.033 mm) dry, per coat.
   b. First and Second Topcoat: Polyurethane, two-component, pigmented, gloss: S-W Pro Industrial Waterbased Acrolon 100 Polyurethane, B65-720 Series, at 2.0 to 4.0 mils (0.051 to 0.102 mm) dry, per coat.

3. Urethane Systems, solvent base, Gloss Finish:

   a. 1st Coat: S-W DTM Wash Primer, B71Y1 (3.4-6.4 mils wet, 0.7-1.3 mils dry).
   b. 2nd Coat: S-W Hi-Solids Polyurethane Gloss, B65/B60-30 Series.
   c. 3rd Coat: S-W Hi-Solids Polyurethane Gloss, B65/B60-30 Series (4.5-8.0 mils wet, 3.0-5.0 mils dry per coat).

4. Fluoropolymer System: See the Part 2 Article on FLUOROPOLYMER COATINGS.

PART 3 - EXECUTION

3.1 FIELD EXAMINATION

A. As applicable for substrates using field application, and with Applicator present, examine substrates and conditions under FEBR coatings will be applied, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers. Where acceptability of substrate conditions is in question, apply samples and perform in-situ testing to verify compatibility, adhesion, and film integrity of new paint application.

1. Verify suitability of substrates (including surface conditions and compatibility) with existing finishes.
2. Do not begin installation until substrates have been properly prepared.
3. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

    a. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

        1) Confirmation of primer's suitability for expected service conditions.
        2) Confirmation of primer's ability to be top coated with materials specified.

    b. Notify Project Director/COR about anticipated problems before using the coatings specified over substrates primed by others.
    c. Report in writing conditions that may affect application, appearance, or performance of paint.

4. Proceed with coating application only after unsatisfactory conditions have been corrected.

    a. Application of coating indicates acceptance of surfaces and conditions.

3.2 FIELD PREPARATION

A. General:

1. Preparation for coatings in an Applicator’s shop shall be in accordance with the Applicator’s recommendations and applicable industry standards.
2. The following provisions in this Article relate to preparation for field applied coatings.

B. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

C. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

D. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.
2. Ferrous Metal Substrates: Clean ungalvanized ferrous-metal surfaces that have not been shop coated: remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC recommendations.

a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire brush, solvent clean, and touch up with same primer as the shop coat.

3. Nonferrous-Metal Substrates: Clean nonferrous and galvanized surfaces according to manufacturer's written instructions for the type of service, metal substrate, and application required.

a. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

E. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

F. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

G. Comply with manufacturer's written instructions and recommendations, and as applicable in "MPI Architectural Painting Specification Manual" for substrates and coating systems indicated.

1. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer. but not less than the following:

    a. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
    b. SSPC-SP 10/NACE No. 2, requires that 95 percent of surface area be free of visible residue, "Near-White Blast Cleaning."
    c. SSPC-SP 5/NACE No. 1, removes visible rust, mill scale, paint, and foreign matter, "White Metal Blast Cleaning."

2. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
3. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings. Galvanized-metal substrates should not be chromate passivated. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.
4. Aluminum Substrates: Remove loose surface oxidation.

3.3 FIELD APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions. This Article identifies requirements associated with field application; those applications shall also conform to the recommendations in "MPI Architectural Painting Specification Manual."

    1. Use applicators spray or touch-up applicator and techniques.
    2. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
    3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
    4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
    5. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

E. Application Procedures:

1. Apply coatings by spray; brush application for touchup shall be according to manufacturer's written instructions.
2. The number of coats and film thickness required is the same regardless of application method.
3. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.
4. Spray Equipment Application: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.

    a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
    b. Apply each coat to provide the equivalent hiding of brush-applied coats.
    c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

5. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

    a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
    b. Brush out and work brush coats into surfaces in an even film.
    c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

F. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

G. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

H. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.4 FIELD QUALITY CONTROL

A. The provisions of this Article relate to field applications of coatings.

B. Material Testing: Government reserves the right to engage the services of a qualified testing agency to sample coating material being used. When this right is invokes, samples of material

delivered to Project site shall be taken, identified, sealed, and certified in presence of Project Director/COR.

1. Testing agency will perform appropriate tests for the following characteristics as required by Government:

    a. Quantitative materials analysis.
    b. Absorption.
    c. Accelerated weathering.
    d. Accelerated yellowness.
    e. Color retention.
    f. Alkali and mildew resistance.
    g. Abrasion resistance.
    h. Apparent reflectivity.
    i. Washability.
    j. Dry opacity.
    k. Recoating.
    l. Skinning.

C. Dry Film Thickness Testing: Government reserves the right to engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

D. Corrective Actions:

1. Failure of Materials Compliance:

    a. The Government may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

2. Failure of Dry Film Thickness Compliance:

    a. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

E. The Project Director/COR may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the

noncomplying paint. If necessary, Contractor may be required to remove noncomplying paint from previously painted surfaces if, on repainting with specified paint, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

A. The provisions of this Article apply to:

1. Cleaning and protection associated with field application work.
2. Cleaning and protection during touch-up of any FE/BR assembly.
3. Cleaning and protection of FE/BR assemblies after their coating work has been completed.

B. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

C. After completing coating application, clean spattered surfaces.

1. Remove spattered coatings by washing, scraping, or other methods.
2. Do not scratch or damage adjacent finished surfaces.
3. After completing painting, clean glass and paint spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

D. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Project Director/COR, and leave in an undamaged condition.

1. Provide “Wet Paint” signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
2. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces.

E. Dispose of used containers in accordance with requirements of local jurisdiction.

F. Maintain general protection and cleaning of coatings until project is completed. Refer to associated requirements identified within each Specification Section of assemblies that are receiving the high-performance coatings.

3.6 FIELD TOUCH-UP

A. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces of any assembly receiving the coatings of this Section.

B. Surface Preparation:

1. Existing caulk, sealant, and residue/contamination to be completely removed from substrate to be coated by means deemed appropriate by contractor. Do not coat over

caulking. If caulking is not removed, and is painted up to caulking, coating subject to delamination along caulk edge.

2. Solvent clean, per SSPC SP-1, substrate to remove any contamination that may be present, including silicone and chlorides.
3. Abrade substrate to remove gloss and to obtain a minimum surface profile of 1.0 mil for adhesion. This can be accomplished by hand sanding with 120 - 220 grit sandpaper or equal. Care should be taken not to abrade the surface too aggressively as surface defects may be visible when coated, but surface should be sanded and dull.
4. Prior to coating, Solvent wipe substrate to remove dust and residual contamination.

C. Primer and Coating Application:

1. Apply one coat of Epoxy Bonding Primer to achieve 2.0 – 3.0 mils DFT. Allow primer to cure 6 hours minimum before applying topcoat. May require multiple passes, or stripe coats to edges.
2. Apply one coat of topcoat per instructions on the respective products technical data bulletin. May require multiple passes, or stripe coats to edges to achieve 1.8 to 2.2 mils.
3. For Metallic coatings require a clear finish coat. The clear coat protects the aluminum pigmentation from ultra-violet degradation. Allow metallic topcoat to dry 4 hours minimum before topcoating. Light Mica colors may require a barrier coat to achieve a1.5 to 2.2 mils DFT. Locations with Extreme atmospheric corrosivity levels may require a Clear Coat.
4. Full cure will be achieved in three to seven days.

HIGH-PERFORMANCE FE/BR COATING APPLICATIONS

Material	Bases for Teller Window or Deal Drawer Window	Frames for Windows, Curtain Walls, & Doors (covered by snap-on trim)	Windows & Curtain Walls (snap-on trim and any exposed finishes)	Doors	Louvers	Hatches
Hot-Dipped Galvanized	Fluoro-polymer	N/A	N/A	Fluoro-polymer	Fluoro-polymer	N/A
Aluminum	Fluoro-polymer or Anodized (see Div. 08 assembly specs; only for Moderate	Fluoro-polymer or Anodized (see Div. 08 assembly specs)	Fluoro-polymer or Anodized (see Div. 08 assembly specs only for Moderate	Fluoro-polymer	Fluoro-polymer	Fluoro-polymer

	corrosion (ACL))		corrosion (ACL))			
Stainless Steel (not cladding/ trim)	N/A	N/A	N/A	Fluoro-polymer	Fluoro-polymer	Fluoro-polymer

END OF SECTION 099602

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Markerboards, Dry Erase Magnetic.
2. Markerboards, Glass Magnetic.
3. Tackboards.
4. Sliding Visual Display Assembly.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.

B. Sustainable Design Submittals:

1. Product Data: For installation adhesives, indicating VOC content.
2. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
3. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For visual display units.

1. Include plans, elevations, sections, details, and attachment to other work.
2. Show locations of panel joints.
3. Show locations and layout of special-purpose graphics.
4. Include sections of typical trim members.

D. Samples: For each type of visual display unit indicated.

1. Visual Display Panel: Not less than 215 by 280 mm (8-1/2 by 11 inches), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 150-mm- (6-inch-) long sections of each trim profile.

3. Display Rail: 150-mm- (6-inch-) long section of each type.
4. Rail Support System: 150-mm- (6-inch-) long sections.
5. Accessories: Full-size Sample of each type of accessory.

E. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: For each visual display unit, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. **[Operation and]**Maintenance Data: For visual display units to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. [Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.]

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups of typical visual display unit as shown on Drawings. Include accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR, based on input from the A/E of Record, specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.

1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: **[50] [450] <Insert value>** or less.

2.2 MARKERBOARDS, DRY ERASE, MAGNETIC (OBO COMPONENT CODE SQ008)

A. Assembly: Markerboard, **[Field] [or] [factory]** fabricated.

1. Corners: **[Square] [Rounded]**.
2. Width: **[As indicated on Drawings] <Insert dimension>**.
3. Height: **[As indicated on Drawings] <Insert dimension>**.

4. Mounting Method: **[Direct to wall] [Rail support system] [Modular support system]**.

B. Markerboard Panel: **[Porcelain-enamel-faced] [High-pressure laminate-faced] [Melamine-faced]** markerboard panel on core indicated.

1. Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors] <Insert color>**.

a. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with **[high-gloss] [low-gloss]** finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.

1) Face Sheet Thickness: **[0.53 mm 90.021 inch)] [0.33 mm (0.013 inch)]** uncoated base metal thickness.

2) Manufacturer's Standard Core: Minimum 6 mm (1/4 inch) thick, with manufacturer's standard moisture-barrier backing.

3) Hardboard Core: 6 mm (1/4 inch) thick; with **[0.127-mm- (0.005-inch-) thick, aluminum foil] [0.38- (0.015-inch-) mm- thick, aluminum sheet] [0.33-mm- (0.013-inch-) thick, galvanized-steel sheet]** backing.
4) Particleboard Core: **[9.5 mm (3/8 inch)] [13 mm (1/2 inch)] thick; with [0.127- (0.005-inch-) mm- thick, aluminum foil] [0.38-mm- (0.015-inch-) thick, aluminum sheet] [0.33-mm- (0.013-inch-) thick, galvanized-steel sheet]** backing.
5) Fiberboard Core: **[9.5 mm (3/8 inch)] [13 mm (1/2 inch)] thick; with [0.025- (0.001-inch-) mm- thick, aluminum foil] [0.38-mm- (0.015-inch-) thick, aluminum sheet] [0.33-mm- (0.013-inch-) thick, galvanized-steel sheet]** backing.
6) Medium-Density Fiberboard Core: 11 mm (7/16 inch) thick; with manufacturer's standard moisture-barrier backing.
7) Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

b. High-Pressure-Laminate Markerboard Panels: Factory-laminated markerboard panel of three-ply construction, consisting of backing, fiberboard core material, and high-pressure-laminate writing surface.
c. Melamine Markerboard Panels: Fabricated from 6-mm- (1/4-inch-) thick, sealed and primed hardboard panels permanently bonded with thermally fused, melamine-impregnated decorative paper writing surface.

C. Aluminum Frames**[and Trim]: Fabricated from not less than 1.57-mm- (0.062-inch-) thick, extruded aluminum; [standard size and shape] [slim size and standard shape] [of size and shape indicated on Drawings] <Insert size and shape>**.

1. Field-Applied Trim: Manufacturer's standard, **[snap-on trim with no visible screws or exposed joints] [slip-on trim] [screw-on trim with Phillips flat-head screws]**.
2. Aluminum Finish: **[Clear anodic] [Color anodic] [Manufacturer's standard baked-enamel or powder-coat]** finish.

a. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors and color densities] <Insert color>**.

D. Factory-Applied Wood Trim: **[Red oak] [Walnut] [Manufacturer's standard species] <Insert species>, not less than 13 mm (1/2 inch) thick; [standard size and shape] [of size and shape indicated on Drawings] <Insert size and shape>** with **[opaque] [transparent]** finish.

E. Field-Applied Wood Trim: Comply with requirements specified in Division 06 Section on "Interior Architectural Woodwork."

F. Vinyl Trim: **[Dark brown] [Black] [As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors]**.

G. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, **[balanced around center of board, as acceptable to Project Director/COR, based on input from the A/E of Record.] [as indicated on approved Shop Drawings]**.

H. Accessory tray: Manufacturer's standard; continuous.

1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
2. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

2.3 MARKERBOARDS, GLASS MAGNETIC (OBO COMPONENT CODE SQ067)

A. Assembly: Glass Magnetic Markerboard, **[Field] [or] [factory]** fabricated.

1. Corners: **[Square] [Rounded]**.
2. Width: **[As indicated on Drawings] <Insert dimension>**.
3. Height: **[As indicated on Drawings] <Insert dimension>**.

B. Glass Markerboards: Fabricated of **[6-mm (1/4 inch) tempered] [or] [6-mm (1/4 inch) tempered-laminated] [low-iron] [ultra-thin]** glass**[with steel backing for use with magnets]**.

1. Edge Treatment: Smooth polished edge with **[rounded] [eased]** corners.
2. Frame: Aluminum trim in profile indicated.
3. Surface: **[Glossy] [Matte]**.
4. Color: **[White] [Gray] [Translucent] [Clear] [Black] [Red] [Blue] <Insert color>**.

C. Mounting: Round, stainless steel standoffs, holding glass approximately **[25 mm (1 inch)] <Insert dimension>** from wall surface; mounted **[through holes in] [in notches in standoffs at top and bottom edges of]** markerboard.

D. Mounting: Concealed, Z-shaped brackets.

E. Mounting: Manufacturer's standard adhesive or adhesive-foam tape mounting.

F. Marker Tray: **[Glass] [Aluminum]**, attached with **[stainless steel clips] [magnet]**.

G. Glass Magnetic Markerboard Accessories: Provide glass magnetic markerboard manufacturer’s neodymium rare-earth magnets packet of **[twenty] <Insert number>** for each glass magnetic markerboard panel.

2.4 TACKBOARDS (OBO COMPONENT CODE SQ003)

A. Assembly: Markerboard, **[Field] [or] [factory]** fabricated.

1. Corners: **[Square] [Rounded]**.

2. Width: **[As indicated on Drawings] <Insert dimension>**.
3. Height: **[As indicated on Drawings] <Insert dimension>**.

4. Mounting Method: **[Direct to wall] [Rail support system] [Modular support system]**.

B. Tackboard Panel: **[Natural-cork] [Plastic-impregnated-cork] [Vinyl-fabric-faced] [Polyester-fabric-faced]** tackboard panel on core indicated.

1. Fabric Wrapped Edge: Wrap edge of tackboard panel with fabric facing.
2. Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors]**.

C. Aluminum Frames**[and Trim]: Fabricated from not less than 1.57-mm- (0.062-inch-) thick, extruded aluminum; [standard size and shape] [slim size and standard shape] [of size and shape indicated on Drawings] <Insert size and shape>**.

1. Field-Applied Trim: Manufacturer's standard, **[snap-on trim with no visible screws or exposed joints] [slip-on trim] [screw-on trim with Phillips flat-head screws]**.
2. Aluminum Finish: **[Clear anodic] [Color anodic] [Manufacturer's standard baked-enamel or powder-coat]** finish.

a. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors and color densities] <Insert color>**.

D. Factory-Applied Wood Trim: **[Red oak] [Walnut] [Manufacturer's standard species] <Insert species>**, not less than 13 mm (1/2 inch) thick; **[standard size and shape] [of size and shape indicated on Drawings] <Insert size and shape>** with **[opaque] [transparent]** finish.

E. Field-Applied Wood Trim: Comply with requirements specified in Division 06 Section on "Interior Architectural Woodwork."

F. Vinyl Trim: **[Dark brown] [Black] [As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors]**.

G. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, **[balanced around center of board, as acceptable to Project Director/COR, based on input from the A/E of Record.] [as indicated on approved Shop Drawings]**.

H. Accessory tray: Manufacturer's standard; continuous.

1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
2. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

2.5 SLIDING VISUAL DISPLAY ASSEMBLY

A. Markerboard (OBO Component Code SQ068)

B. Tackboard (OBO Component Code SQ069)

C. Dual Track (OBO Component Code SQ176)

1. Horizontal-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed rear visual display panel, aluminum-framed horizontal-sliding visual display panels, and extruded-aluminum fascia that conceals overhead sliding track; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.

   a. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall length of unit.
   b. Hardware: Manufacturer's standard, extruded-aluminum overhead track and channel-shaped bottom guides; with two nylon ball-bearing carriers and two nylon rollers for each sliding panel.
   c. Overall Width: **[As indicated on Drawings] <Insert dimension>**.
   d. Overall Height: **[As indicated on Drawings] <Insert dimension>**.

2. Panels and Accessories:

   a. Sliding Markerboard Panel: **[Porcelain-enamel-faced] [High-pressure laminate-faced]** markerboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than **[9.5 mm thick (3/8 inch)] <Insert dimension>**.

      1) Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors] <Insert color>**.

   b. Sliding Tackboard Panel: **[Natural-cork] [Plastic-impregnated-cork] [Vinyl-fabric-faced] [Polyester-fabric-faced]** tackboard panel on kraft-paper honeycomb core designed to be rigid and to resist warpage, not less than **[9.5 mm thick (3/8 inch)] <Insert dimension>**.

      1) Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors]**.

   c. Fixed Rear Markerboard Panel: **[Porcelain-enamel-faced] [High-pressure laminate-faced]** markerboard panel on core indicated.

      1) Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by**

Project Director/COR, based on input from the A/E of Record, from full range of industry colors] <Insert color>.

d. Fixed Rear Tackboard Panel: **[Natural-cork] [Plastic-impregnated-cork] [Vinyl-fabric-faced] [Polyester-fabric-faced]** tackboard panel on core indicated.

1) Color and Pattern: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from full range of industry colors]**.

e. Accessories: **[Accessory tray] [locks] [and] [easel pad clamps]**.

f. Aluminum Trim: **[Factory applied] [Field applied]; in [manufacturer's standard] <Insert description> size and profile; with [clear anodic] <Insert description>** finish.

2.6 MATERIALS

A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.

B. High-Pressure Plastic Laminate: NEMA LD 3.

C. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering

D. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish**[with surface-burning characteristics indicated]**.

E. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout[with surface-burning characteristics indicated].

F. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, **[burlap weave] <Insert texture or pattern>**; weighing not less than 440 g/sq. m (13 oz./sq. yd.); with surface-burning characteristics indicated.

G. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than 508 g/sq. m (15 oz./sq. yd.); with surface-burning characteristics indicated.

H. Composite Wood Products: Products shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde.

I. Hardboard: ANSI A135.4, tempered.

J. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.

K. Medium-Density Fiberboard: ANSI A208.2, Grade 130.

L. Fiberboard: ASTM C 208 cellulosic fiber insulating board.

M. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.

N. Extruded Aluminum: ASTM B 221M, Alloy 6063.

O. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.

1. Adhesives shall have a VOC content of **[50]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

P. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 interior painting section and recommended in writing by visual display unit manufacturer for intended substrate.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of 0.04 mm. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine walls and partitions for proper preparation and backing for visual display units.

C. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.

D. Prime wall surfaces indicated to receive **[visual display units] [direct-applied floor-to-ceiling visual display assemblies]** and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.

E. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, **[balanced around center of board, as acceptable to Project Director/COR] [as indicated on approved Shop Drawings]**.

2. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's standard structural support accessories to suit conditions indicated.

C. Factory-Fabricated Visual Display Board Assemblies: Adhere to wall surfaces with **[egg-size] <Insert coverage>** adhesive gobs at 400 mm (16 inches) o.c. horizontally and vertically.

D. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 400 mm o.c. (16 inches) Secure tops and bottoms of boards to walls.

E. Visual Display Board Assembly Mounting Heights: Install visual display units at mounting heights indicated on Drawings.

F. Display Rails: Install rails at mounting heights indicated on Drawings. Attach to wall surface with fasteners at not more than 400 mm o.c.

G. Sliding Visual Display Units: Install units at mounting heights indicated. Attach to wall framing with fasteners at not more than 400 mm (16 inches) o.c.

1. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.4 CLEANING AND PROTECTION

A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display units after installation and cleaning.

3.5 DEMONSTRATION

A. **[Engage a factory-authorized service representative to train] [Train]** Project Director/COR's maintenance personnel to adjust, operate, and maintain sliding visual display units.

END OF SECTION 101100

SECTION 101415 - POST AND PANEL/PYLON EXTERIOR SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonilluminated post-and-panel signs.
2. Nonilluminated pylon signs.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete foundations, concrete fill in postholes, and setting anchor bolts in concrete foundations for signs.

1.2 DEFINITIONS

A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

A. Furnish templates and tolerance information for placement of sign-anchorage devices embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For signage.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least **[half size]** <**Insert scale**>.

C. Samples for Verification: For each type of sign assembly, showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Typestyles and Graphic Symbols: Include representative samples.
2. Post-and-Panel Signs: **[Full-size Sample] [Not less than 300 mm square, including corner and post]** <Insert size>.

3. Pylon Signs: **[Full-size Sample] [Not less than 300 mm square, including corner]** <Insert size>.
4. Variable Component Materials: **[Full-size Sample] [200-mm Sample] <Insert size>** of each base material, character or graphic element, in each exposed color and finish not included in other Samples.
5. Exposed Accessories: **[Full-size Sample] [Half-size Sample] <Insert size>** of each accessory type.

6. Full-size Samples, if approved, will be returned to Contractor for use in Project.

D. Product Schedule: For post-and-panel and pylon signs. Use same designations indicated on Drawings or specified.

E. Delegated-Design Submittal: For signs types indicated in "Performance Requirements" Article.

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[Installer] [and] [manufacturer]**.

B. Evaluation Reports: For **[post-installed anchors] [and] [power-actuated fasteners]**, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials**[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Variable Component Materials: **[12] <Insert number>** replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
2. Tools: **[One] <Insert number>** set(s) of specialty tools for assembling signs and replacing variable sign components.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: **[Manufacturer of products] [An entity that employs installers and supervisors who are trained and approved by manufacturer]**.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of **[anchorage devices]** embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design sign structure and anchorage of post-and-panel and pylon sign type(s) <**Insert drawing designation of sign(s)**> according to structural performance requirements.

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated and specified.

1. Uniform and concentrated loads need not be assumed to act concurrently.

C. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

D. Accessibility Standard: Comply with applicable provisions in Chapter 11 of the OBO Building Code.

2.2 POST-AND-PANEL SIGNS

A. Post-and-Panel Sign <**Insert drawing designation**>: Sign of single-panel configuration; with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Solid-Sheet Sign Panels: Aluminum sheet with finish specified in "Sign-Panel-Face Finish and Applied Graphics" Subparagraph and as follows:

a. Thickness: 6 mm.

2. Sign-Frame Mounting: Mounting bracket welded to panel and mounted to post with countersunk tamperproof mechanical fasteners, as required. **[Over posts] [As indicated on Drawings]** <**Insert description**>.
3. Posts: Extruded metal.

a. Shape: Square.
b. Size: **[50 by 50 mm][38 by 38 (1 ½ by 1 ½ inches)][25 by 25 mm (1 by 1 inches)]**in accordance with OBO signage and Wayfinding Design Guide.
c. Installation Method: Install in accordance with OBO signage and Wayfinding Design Guide.

d. Finish and Color: Dark blue exterior-grade painted posts and mounting brackets with dark blue plastic cap; match Project Director/COR Project Director/COR's sample.

4. Sign-Panel-Face Finish and Applied Graphics:

a. Integral Metal Finish: : **[White exterior-grade painted metal panel with dark blue silkscreened text] [Match Project Director/COR's sample]**.
b. Integral Aluminum Finish: **[White painted aluminum panel with dark blue frisket painted text and symbols] [Match Project Director/COR's sample]**.

2.3 PYLON SIGNS

A. Pylon Sign <**Insert drawing designation**>: Sign with smooth, uniform surfaces and support assembly; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Solid-Sheet Sign Panels**[and Returns][, Returns, and Back]**: Aluminum sheet with finish specified in "Sign-Panel-Face Finish and Applied Graphics" Subparagraph and as follows:

a. Thickness: **[As indicated on Drawings] [25 mm (1.00 inch)][178 mm (7.00 inches)]**.
b. Surface-Applied Graphics: Comply with OBO Signage and Wayfinding Design Guide. **[Water-jet cut aluminum letters mounted flush to pylon with fully concealed mechanical fasteners]**.

2. Sign-Frame Mounting: **[Between pylon supports] [Over pylon supports] [As indicated on Drawings]**.

3. Pylon Structure:

a. Pylon Shape: **[Rectangular] [Square] [As indicated on Drawings]**.
b. Pylon Construction: As indicated on Drawings and in compliance with OBO Signage and Wayfinding Guidelines.
c. Pylon Base: **[Stone fabricated base][Concrete footing platform][as indicated on Drawings]** and in accordance with OBO Signage and Wayfinding Guidelines.

4. Sign-Panel-Face Finish and Applied Graphics:

a. Integral Metal Finish: **[As indicated on Drawings] [Frisket painted text and symbols] [Match Project Director/COR Project Director/COR's sample]**.
b. Integral Aluminum Finish: **[As indicated on Drawings] [Frisket painted text and symbols] [Match Project Director/COR's sample]**.
c. Painted Finish and Graphics: **[Painted water-jet cut aluminum letter mounted flush with fully concealed mechanical fasteners][As indicated on Drawings] [matching Project Director/COR's sample]**.

2.4 MATERIALS

A. Aluminum Sheet and Plate: ASTM B 209M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: ASTM B 221M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Steel Materials:

1. Hot-Rolled, Structural-Steel Shapes: ASTM A 36/A 36M or ASTM A 529/A 529M.
2. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 290-MPa minimum yield strength.
3. Steel Tubing or Pipe: ASTM A 500/A 500M, Grade B.
4. Bolts for Steel Framing: ASTM A 307 or ASTM A 325M as necessary for design loads and connection details.
5. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.

D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, [**Type 304,**] [**Type 316,**] stretcher-leveled standard of flatness.

E. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.5 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish **[nonferrous-metal] [stainless-steel] [or] [hot-dip galvanized] <Insert requirement>** devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.

b. Fastener Heads: For nonstructural connections, use **[flathead] [or] [oval countersunk]** <Insert shape> screws and bolts with tamper-resistant, **[Allen-head] [spanner-head] [or] [one-way-head]** <Insert slot design> slots unless otherwise indicated.

4. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on **[ICC-ES AC01] [ICC-ES AC193] [ICC-ES AC58] [or] [ICC-ES AC308]** as appropriate for the substrate.

1. Uses: Securing signs with imposed loads to structure.

2. Type: **[Torque-controlled, expansion anchor] [torque-controlled, adhesive anchor] [or] [adhesive anchor]**.
3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941M, Class Fe/Zn 5, unless otherwise indicated.
4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy **[Group A1] [Group A4]** stainless-steel bolts, ASTM F 738M, and nuts, ASTM F 836M.

C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

E. Anchoring Materials:

1. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
2. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

a. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in locations concealed from view after final assembly.
2. Mill joints to tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

4. Conceal fasteners and anchors unless indicated to be exposed; locate exposed fasteners where they will be inconspicuous.
5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.

B. Sign Message Panels: Construct sign-panel surfaces to be smooth and to remain flat under installed conditions within a tolerance of plus or minus 1.5 mm measured diagonally from corner to corner.

1. Coordinate dimensions and attachment methods to produce message panels with closely fitting joints. Align edges and surfaces with one another in the relationship indicated.
2. Increase panel thickness or reinforce with concealed stiffeners or backing materials as needed to produce surfaces without distortion, buckles, warp, or other surface deformations.
3. Continuously weld joints and seams unless other methods are indicated; grind, fill, and dress welds to produce smooth, flush, exposed surfaces with welds invisible after final finishing.

C. Post Fabrication: Fabricate posts designed for structural performance indicated and of lengths required for installation method indicated for each sign.

1. Steel Posts: Fabricate from minimum **[3.05-mm-]** <**Insert dimension**> thick, steel tubing unless otherwise indicated. Include post caps, fillers, spacers, junction boxes, access panels, reinforcement where required for loading conditions, and related accessories required for complete installation.

   a. Hot-dip galvanize post assemblies after fabrication according to ASTM A 123/A 123M.

2. Direct Burial: Fabricate posts 910 mm longer than height of sign to permit direct burial or embedment in concrete foundations or concrete-filled postholes.

3. Baseplates: Fabricate posts with baseplates welded to bottom of posts. Drill holes in baseplate for anchor-bolt connection.

   a. Provide **[preset] [drilled-in-place]** anchor bolts of size required for connecting posts to concrete foundations.

4. Sleeves: Fabricate posts 300 mm longer than height of sign to permit embedment in sleeves cast in concrete foundations or concrete-filled postholes. Provide sleeves by manufacturer, sized to receive outside diameter of posts. Size sleeves for direct embedment in concrete foundations or concrete-filled postholes and to prevent sign movement, but not less than **[610 mm] [910 mm]** <**Insert dimension**> for embedment.

5. Reverse Sleeves: Provide inserts by sign manufacturer, sized for close fit inside posts. Size inserts for direct embedment in concrete foundations and to attach sign posts securely and prevent sign movement, but of a height not less than one-third of post height plus 910 mm for embedment.

a. Provide through bolts to fasten posts to inserts.

D. Pylon Fabrication: Fabricate pylon signs with integral base consisting of channels, angles, plates, or other fittings. Design and fabricate pylon and anchorage for structural performance indicated. Detail anchorage so that water can drain out of assembly without obstruction. Drill holes in members for anchor-bolt connection. Provide anchor bolts of size required for connecting base to concrete foundations.

1. Internal Frames: Manufacturer's standard internal steel framing system and anchorage, modified as required for Project requirements. Provide welded construction. Cut, drill, and tap units to receive hardware, bolts, and similar items.

a. Hot-dip galvanize steel framing system after fabrication according to ASTM A 123/A 123M.

2. External Frames: Manufacturer's standard external aluminum framing system and anchorage for direct attachment of sign message panels, modified as required for Project requirements. Provide welded construction using mitered joints. Cut, drill, and tap units to receive hardware, bolts, and similar items.

a. Hot-dip galvanize steel framing system after fabrication according to ASTM A 123/A 123M.

2.7 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, **[Class I, 0.018 mm] [Class II, 0.010 mm]** or thicker.

B. Color Anodic Finish: AAMA 611, **[Class I, 0.018 mm] [Class II, 0.010 mm]** or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 0.04 mm. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs.

C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install signs using installation methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign components are clean and free of materials or debris that would impair installation.
4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLING POSTS

A. Vertical Tolerance: Set posts plumb within a tolerance of 2 mm in 1 m.

B. Direct-Burial Method:

1. Excavation: Excavate posthole to dimensions indicated. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by freezing temperatures, frost, rain, accumulated water, or construction activities by excavating an additional 300 mm, backfilling with satisfactory soil or well-graded aggregate, and compacting to original subgrade elevation.
2. Setting in Earth: Set post in position, support to prevent movement, and backfill with satisfactory soil or well-graded aggregate as recommended in writing by manufacturer. Place and compact backfill in 150-mm lifts, compacting each lift.
3. Setting in Cast-in-Place Concrete: Set post in position, support to prevent movement, and place concrete **[in posthole] [or] [for concrete foundation]** as indicated on Drawings.

4. Setting in Preformed Hole in Concrete Foundation: Form or core drill holes in concrete foundation not less than 20 mm larger than outside dimension of post for installing posts in concrete. Set post in position, shim to prevent movement, and fill annular space between post and hole with **[nonshrink, nonmetallic grout] [or] [anchoring cement]**, mixed and placed to comply with manufacturer's written instructions.

    a. Cover anchorage joint in concrete foundations with flange of same metal and finish as post, **[welded to post after placing anchoring material] [attached to post with set screws]**.
    b. Leave anchorage joint exposed with **[3-mm anchoring material sloped away from post] [anchoring material flush with adjacent surface]**.

C. Baseplate Method:

1. Preset Anchor Bolts: Set post baseplate in position over anchor bolts projecting from concrete foundation, shim and support post to prevent movement, place washers and nuts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.
2. Drilled-in-Place Anchor Bolts: Set post baseplate in position over concrete foundation, locate and drill anchor holes, shim and support post to prevent movement, place washers and anchor bolts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.

D. Sleeve Method: Set post in position in sleeve and support post to prevent movement, fill annular space between post and sleeve with **[nonshrink, nonmetallic grout] [or] [anchoring cement]**, mixed and placed to comply with manufacturer's written instructions.

1. Cover anchorage joint with flange of same metal and finish as post, **[welded to post after placing anchoring material] [attached to post with set screws]**.
2. Leave anchorage joint exposed with **[3-mm anchoring material sloped away from post] [anchoring material flush with adjacent surface]**.

E. Reverse-Sleeve Method: Set post in position over the projecting insert and support post to prevent movement, drill posts and inserts for through bolts, and install and tighten through bolts.

3.4 INSTALLING PYLONS

A. Vertical Tolerance: Install pylons plumb within a tolerance of 2 mm in 1 m.

B. Attachment with Preset Anchor Bolts: Set pylon base in position over anchor bolts projecting from concrete foundation, shim and support pylon to prevent movement, place washers and nuts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.

C. Attachment with Drilled-in-Place Anchor Bolts: Set pylon base in position over concrete foundation, locate and drill anchor holes, shim and support pylon to prevent movement, place washers and anchor bolts, and tighten. Fill shim space with nonshrink, nonmetallic grout, mixed and placed to comply with manufacturer's written instructions.

3.5 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Project Director/COR.

END OF SECTION 101415

SECTION 101425 – INTERIOR PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panel signs.
2. Illuminated panel signs.

B. Related Requirements:

1. Section 101415 "Post and Panel/Pylon Signage" for freestanding signs.

1.2 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

B. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.

3. Show message list, typestyles, graphic elements**[, including raised characters and Braille]**, and layout for each sign at least **[half size]** <**Insert scale**>.

4. Show locations of electrical service connections.
5. Include diagrams for power, signal, and control wiring.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Panel Signs: **[Full-size Sample] [Not less than 300 mm square, including corner]** <Insert size>.
2. Field-Applied, Vinyl-Character Signs: **[Full-size Sample of characters on glass]** <Insert requirement>.
3. Variable Component Materials: **[Full-size Sample] [200-mm Sample]** <**Insert size**> of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
4. Exposed Accessories: **[Full-size Sample] [Half-size Sample]** <**Insert size**> of each accessory type.
5. Full-size Samples, if approved, will be returned to Contractor for use in Project.

E. Product Schedule: For panel signs. Use same designations indicated on Drawings or specified.

F. **[Delegated-Design Submittal: For [signs indicated in "Performance Requirements" Article] <Insert sign designations>**.

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.]

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[Installer] [and] [manufacturer]**.

B. Evaluation Reports: For **[post-installed anchors] [and] [power-actuated fasteners]**, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials**[, from the same product run,]** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Variable Component Materials: **[12]** <**Insert number**> replaceable text inserts and interchangeable characters (letters, numbers, and graphic elements) of each type.
2. Tools: **[One]** <**Insert number**> set(s) of specialty tools for assembling signs and replacing variable sign components.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Comply with requirements of the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of **[anchorage devices] [and] [electrical service]** embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. [Delegated Design: Engage a qualified professional engineer to design sign structure and anchorage of [illuminated panel] <Insert description> sign type(s) <Insert drawing designation of sign(s)> according to structural performance requirements.]

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

C. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

2.2 PANEL SIGNS

A. Panel Sign <**Insert drawing designation**>: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Illuminated Panel Sign: **[Backlighted] [Edgelighted]** construction with **[fluorescent tube] [fiber-optic] [LED] [neon tube]** <**Insert requirement**> lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from sign surfaces as needed to illuminate evenly.

   a. Power: As indicated on electrical Drawings.

2. Solid-Sheet Sign**[and Returns][, Returns, and Back]**: Aluminum sheet with finish specified in "Surface Finish and Applied Graphics" Subparagraph and as follows:

   a. Thickness: **[As indicated on Drawings] [Manufacturer's standard for size of sign] [1.52 mm] [2.03 mm] [3.18 mm] [6.35 mm]** <Insert dimension>.

   b. Surface-Applied, Flat Graphics: Applied **[vinyl film] [baked enamel or powder coat] [paint] [photo image]** <Insert requirement>.
   c. Surface-Applied, Raised Graphics: Applied **[polymer characters] [and] [Braille]** <Insert requirement>.
   d. Etched and Filled Graphics: Sign face etched or routed to receive enamel-paint infill.
   e. Inset, Cutout Characters: Sign face routed to receive push-through acrylic graphics **[flush with] [slightly projecting from]** the sign panel.

3. Laminated Aluminum-Sheet Sign: Aluminum sheet laminated to both sides of **[acrylic] [phenolic]** <**Insert material**> core sheet**[with painted edges]**.

   a. Composite-Sheet Thickness: **[As indicated on Drawings] [Manufacturer's standard for size of sign] [3.18 mm] [6.35 mm]** <Insert dimension>.

   b. Surface-Applied, Flat Graphics: Applied **[vinyl film] [paint] [photo image]** <Insert requirement>.
   c. Surface-Applied, Raised Graphics: Applied **[polymer characters] [and] [Braille]** <Insert requirement>.

4. Laminated-Sheet Sign: **[Photopolymer] [Sandblasted polymer]** <**Insert material**> face sheet with raised graphics laminated**[over subsurface graphics]** to **[acrylic] [phenolic]** <**Insert material**> backing sheet to produce composite sheet.

   a. Composite-Sheet Thickness: **[As indicated on Drawings] [Manufacturer's standard for size of sign] [3.18 mm] [6.35 mm]** <Insert dimension>.

   b. Surface-Applied, Flat Graphics: Applied **[vinyl film] [paint] [photo image]** <Insert requirement>.
   c. Surface-Applied, Raised Graphics: Applied **[polymer characters] [and] [Braille]** <Insert requirement>.
   d. Subsurface Graphics: **[Reverse halftone or dot-screen image] [Reverse etch image] [Snap-in changeable insert beneath removable face sheet] [Slide-in changeable insert]** <Insert requirement>.

5. Composite Phenolic-Core Sign: Solid phenolic panel core with integral subsurface graphic image covered with integral, polymeric face layer.

    a. Composite-Sheet Thickness: **[As indicated on Drawings] [Manufacturer's standard for size of sign] [12.7 mm] [25.4 mm]** <Insert dimension>.

6. Laminated Polycarbonate-Sheet Sign: Polycarbonate face sheet laminated to each side of **[phenolic]** <**Insert material**> base sheet to produce composite sheet.

    a. Composite-Sheet Thickness: **[As indicated on Drawings] [Manufacturer's standard for size of sign] [3.18 mm] [6.35 mm]** <Insert dimension>.

    b. Surface-Applied, Flat Graphics: Applied **[vinyl film] [paint] [photo image]** <Insert requirement>.
    c. Surface-Applied, Raised Graphics: Applied **[polymer characters] [and] [Braille]** <Insert requirement>.
    d. Subsurface Graphics: **[Reverse halftone or dot-screen image] [Reverse etch image]** <Insert requirement>.

7. Engraved Plastic-Laminate Sign: Plastic-laminate face laminated to contrasting phenolic core to produce composite sheet.

    a. Composite-Sheet Thickness: **[As indicated on Drawings] [Manufacturer's standard for size of sign] [3.18 mm] [6.35 mm]** <Insert dimension>.
    b. Engraved Graphics: Characters engraved through plastic-laminate face sheet to expose contrasting phenolic core.
    c. Plastic-Laminate Color and Pattern: **[As indicated by manufacturer's designation] [As selected by Project Director/COR from OBO Signage and Wayfinding Design Guide's 's standard range]** <Insert color and pattern>.
    d. Core Color: OBO Signage and Wayfinding Design Guide's standard **[dark color]** <Insert color>.

8. Sign-Panel Perimeter: Finish edges smooth.

    a. Edge Condition**[at Vertical Edges][at Horizontal Edges]**: **[As indicated on Drawings] [Square cut] [Beveled] [Bullnosed]** <Insert requirement>.
    b. Corner Condition in Elevation: **[As indicated on Drawings] [Square] [Rounded to radius indicated]** <Insert requirement>.

9. Mounting: **[As indicated on Drawings] [Manufacturer's standard method for substrates indicated] [Surface mounted to wall] [Projecting from wall] [Suspended] [Aluminum bracket] [Stainless-steel bracket]** <Insert requirement> with **[concealed anchors] [countersunk flathead through fasteners] [adhesive] [two-face tape] [hook-and-loop tape] [or] [magnetic tape]**.
10. Surface Finish and Applied Graphics:

    a. Integral Metal Finish: **[Mill] [Antique oxidized] [As indicated by manufacturer's designation] [Match Project Director/COR's sample] [As selected by Project Director/COR from full range of industry finishes]** <Insert finish>.

b. Integral Aluminum Finish: **[Clear anodized] [Light bronze anodized] [Medium bronze anodized] [Match Project Director/COR's sample] [Anodized color as selected by Project Director/COR from full range of industry colors and color densities]** <Insert finish>.
c. Integral Stainless-Steel Finish: **[No. 4] [No. 8] [Match Project Director/COR's sample] [As selected by Project Director/COR from full range of industry finishes]** <Insert description>.
d. Integral **[Acrylic] [Fiberglass] [PVC]** Sheet Color: **[As indicated by manufacturer's designation] [Match Project Director/COR's sample] [As selected by Project Director/COR from full range of industry colors]** <Insert color>.
e. Baked-Enamel or Powder-Coat Finish and Graphics: Manufacturer's standard, in color **[as indicated by manufacturer's designation] [matching Project Director/COR's sample] [as selected by Project Director/COR from manufacturer's full range]** <Insert color>.
f. Painted Finish and Graphics: Manufacturer's standard, factory-applied **[acrylic polyurethane]** <Insert requirement>, in color **[as indicated by manufacturer's designation] [matching Project Director/COR's sample] [as selected by Project Director/COR from manufacturer's full range]** <Insert color>.
g. Photo-Image Graphics: Manufacturer's standard **[black-and-white] [multicolor]**, **[600-dpi]** <Insert value> halftone or dot-screen image.
h. Overcoat: **[Manufacturer's standard baked-on clear coating]** <Insert requirement>.

11. Flatness Tolerance: Sign shall remain flat or uniformly curved under installed conditions as indicated on Drawings and within a tolerance of plus or minus 1.5 mm measured diagonally from corner to corner.

2.3 PANEL-SIGN MATERIALS

A. Aluminum Sheet and Plate: ASTM B 209M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: ASTM B 221M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

D. Fiberglass Sheet: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.

E. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.

F. PVC Sheet: Manufacturer's standard, UV-light stable, PVC plastic.

G. Plastic-Laminate Sheet: NEMA LD 3, general-purpose HGS grade, 1.2-mm nominal thickness.

H. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings.

I. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. Exposed Metal-Fastener Components, General:

   a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
   b. Fastener Heads: For nonstructural connections, use **[flathead] [or] [oval countersunk]** <Insert shape> screws and bolts with tamper-resistant **[Allen-head] [spanner-head] [or] [one-way-head]** <Insert slot design> slots unless otherwise indicated.

3. Sign Mounting Fasteners:

   a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
   b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
   c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

4. Inserts: Furnish inserts to be set by other installers into concrete or masonry work.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on **[ICC-ES AC01] [ICC-ES AC193] [ICC-ES AC58] [or] [ICC-ES AC308]** as appropriate for the substrate.

1. Uses: Securing signs with imposed loads to structure.
2. Type: **[Torque-controlled, expansion anchor] [torque-controlled, adhesive anchor] [or] [adhesive anchor]**.
3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941M, Class Fe/Zn 5, unless otherwise indicated.

C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Adhesive: As recommended by sign manufacturer.

1. Adhesives shall have a VOC content of **[70]** <**Insert value**> g/L or less.

2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.

E. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 1.14 mm thick, with adhesive on both sides.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into indicated sign surface to produce precisely formed copy, incised to uniform depth.

1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.

C. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

D. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

E. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

F. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:

1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. **[Subsequent changeable inserts are by Project Director/COR] [Furnish two blank inserts for each sign for Project Director/COR's use] <Insert requirement>**.
2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. **[Subsequent changeable inserts are by Project Director/COR] [Furnish two blank inserts for each sign for Project Director/COR's use] <Insert requirement>**.
3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. **[Subsequent changeable sign panels are by Project Director/COR] <Insert requirement>**.

G. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish **[to match sign-background color] [to match Project Director/COR's sample] <Insert requirement>** color unless otherwise indicated.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, **[Class I, 0.018 mm] [Class II, 0.010 mm]** or thicker.

B. Color Anodic Finish: AAMA 611, **[Class I, 0.018 mm] [Class II, 0.010 mm]** or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 0.04 mm. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.

D. Verify that electrical service is correctly sized and located to accommodate signs.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Accessible Signage: Install in locations on walls **[as indicated on Drawings] [and] [according to the accessibility standard]** <Insert requirement>.

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
7. Shim-Plate Mounting: Provide 3-mm- thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using <**Insert mounting method**> method specified above.

D. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Project Director/COR.

END OF SECTION 101425

SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes toilet compartments configured as toilet enclosures and urinal screens.

B. Material Index / Material Codes Include:

1. TOG-[##] <TOILET COMPARTMENTS.>

C. Related Requirements:

1. Division 05 Section on “Metal Fabrications” for metal support framing.
2. Division 06 Section on “Rough Carpentry” for blocking.
3. Division 10 section on "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: For toilet compartments.

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
4. Show locations of centerlines of toilet fixtures.
5. Show locations of floor drains.
6. Show **[ceiling grid, ceiling-mounted items, and]** overhead support or bracing locations.

D. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of toilet compartment.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: **[One]** <**Insert number**> hinge(s) with associated fasteners.
2. Latch and Keeper: **[One]** <**Insert number**> latch(es) and keeper(s) with associated fasteners.
3. Door Bumper: **[One]** <**Insert number**> door bumper(s) with associated fasteners.
4. Door Pull: **[One]** <**Insert number**> door pull(s) with associated fasteners.
5. Fasteners: **[Ten]** <**Insert number**> fasteners of each size and type.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **[25]** <**Insert value**> percent.

B. Regulatory Requirements: Comply with applicable provisions in OBO-ICS Chapter 11 for toilet compartments designated as accessible.

C. Provide no-sightline system for all toilet compartments unless otherwise noted.

2.2 STAINLESS-STEEL TOILET COMPARTMENTS **[TOG-[##]]**

A. Toilet-Enclosure Style: Floor anchored.

B. Urinal-Screen Style: Floor anchored.

C. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide with no-sightline system. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.

1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 25 mm for doors and panels and 32 mm for pilasters.
2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units of size and material adequate for panel to withstand applied downward load on grab bar of at least 1112 N, when tested according to ASTM F 446, without deformation of panel.
3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

D. Urinal-Screen Construction:

1. Flat-Panel Urinal Screen: Matching panel construction.

E. Facing Sheets and Closures: Stainless-steel sheet of nominal thicknesses as follows:

1. Pilasters, Unbraced at One End: Manufacturer's standard thickness, but not less than 1.27 mm.
2. Panels: Manufacturer's standard thickness, but not less than 0.79 mm.
3. Doors: Manufacturer's standard thickness, but not less than 0.79 mm.
4. Flat-Panel Urinal Screens: Thickness matching the panels.

F. Pilaster **[Shoes] [and] [Sleeves (Caps)]**: Stainless-steel sheet, not less than 0.79-mm nominal thickness and 76 mm high, finished to match hardware.

G. Urinal-Screen Post: Manufacturer's standard post design of **[material matching the thickness and construction of pilasters] [or] [44-mm- square, aluminum tube with satin finish]** <In**sert requirement**>; with shoe**[and sleeve (cap)]** matching that on the pilaster.

H. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets; **[chrome-plated zamac] [clear-anodized aluminum] [stainless steel] [chrome-plated brass]**.
2. Full-Height (Continuous) Type: Manufacturer's standard design; **[stainless steel] [aluminum]**.

I. Stainless-Steel Finish: No. 4 bright, directional polish on exposed faces. Protect exposed surfaces from damage by application of strippable, temporary protective covering before shipment.

2.3 PAINTED STEEL TOILET COMPARTMENTS **[TOG-[##]]**

A. Toilet-Enclosure Style: Floor anchored.

B. Urinal-Screen Style: Floor anchored.

C. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide with no-sightline system. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.

1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.
2. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units of size and material adequate for panel to withstand applied downward load on grab bar of at least 250 lbf (1112 N), when tested according to ASTM F 446, without deformation of panel.
3. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

D. Urinal-Screen Construction:

1. Flat-Panel Urinal Screen: Matching panel construction.
2. Integral-Flange, Wall-Hung Urinal Screen: Similar to panel construction, with integral full-height flanges for wall attachment, and maximum 1-1/4 inches (32 mm) thick.
3. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum 6 inches (152 mm) wide at wall and minimum 1 inch (25 mm) wide at protruding end.

E. Facing Sheets and Closures: **[Electrolytically coated steel] [or] [hot-dip galvanized-steel]** sheet with nominal base-metal (uncoated) thicknesses as follows:

1. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).
2. Pilasters, Unbraced at One End: Manufacturer's standard thickness, but not less than 0.048 inch (1.21 mm).
3. Panels: **[Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm)] [0.036 inch (0.91 mm)]**.
4. Doors: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).

5. Flat-Panel Urinal Screens: Thickness matching the panels.
6. Integral-Flange, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
7. Wedge-Shaped, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).

F. Pilaster **[Shoes] [and] [Sleeves (Caps)]**: Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

G. Urinal-Screen Post: Manufacturer's standard post design of **[material matching the thickness and construction of pilasters] [or] [1-3/4-inch- (44-mm-) square, aluminum tube with satin finish] <Insert requirement>**; with shoe**[and sleeve (cap)]** matching that on the pilaster.

H. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets; **[chrome-plated zamac] [clear-anodized aluminum] [stainless steel] [chrome-plated brass]**.
2. Full-Height (Continuous) Type: Manufacturer's standard design; **[stainless steel] [aluminum]**.

I. Steel Sheet Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking.

1. Color: **[As indicated by manufacturer's designations] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

a. Allow for application of **[one color] [two colors]** in each room.

2.4 PHENOLIC-CORE TOILET COMPARMENTS **[TOG-[##]]**

A. Toilet-Enclosure Style: Floor anchored.

B. Urinal-Screen Style: Floor anchored.

C. Door, Panel**[, Screen]**, and Pilaster Construction: Solid phenolic-core panel material with melamine facing on both sides fused to substrate during panel manufacture (not separately laminated), and with eased and polished edges and no-sightline system. Provide minimum 3/4-inch- (19-mm-) thick doors and pilasters and minimum 1/2-inch- (13-mm-) thick panels.

D. Pilaster **[Shoes] [and] [Sleeves (Caps)]**: Formed from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

E. Urinal-Screen Post: Manufacturer's standard post design of **[monolithic phenolic urinal screen cutout at bottom to form a post] [material matching the thickness and construction of pilasters] [or] [1-3/4-inch- (44-mm-) square, aluminum tube with satin finish] <Insert requirement>**; with shoe**[and sleeve (cap)]** matching that on the pilaster.

F. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets, **[chrome-plated zamac] [clear-anodized aluminum] [stainless steel] [chrome-plated brass]**.
2. Full-Height (Continuous) Type: Manufacturer's standard design; **[stainless steel] [aluminum]**.

G. Phenolic-Panel Finish:

1. Facing Sheet Finish: **[One color and pattern] [Two colors and patterns]** in each room.
2. Color and Pattern: **[As indicated by manufacturer's designations] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and pattern>**, with manufacturer's standard **[dark color core] [through-color core matching face sheet]**.

3. Edge Color: **[Manufacturer's standard] [Through-color matching facing sheet color]**.

2.5 HARDWARE AND ACCESSORIES

A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.

1. Hinges: Manufacturer's minimum 1.59-mm- thick stainless steel **[paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees] [continuous, cam type that swings to a closed or partially open position] [continuous, spring-loaded type] <Insert requirement>**, allowing emergency access by lifting door. Mount with through-bolts.
2. Latch and Keeper: Manufacturer's heavy-duty surface-mounted cast-stainless-steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.
3. Coat Hook: Manufacturer's heavy-duty combination cast-stainless-steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
4. Door Bumper: Manufacturer's heavy-duty rubber-tipped cast-stainless-steel bumper at out-swinging doors**[and entrance-screen doors]**. Mount with through-bolts.
5. Door Pull: Manufacturer's heavy-duty cast-stainless-steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless-steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel anchors compatible with related materials.

2.6 MATERIALS

A. Aluminum Castings: ASTM B 26/B 26M.

B. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.

C. Stainless-Steel Castings: ASTM A 743/A 743M.

2.7 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories and solid blocking within panel where required for attachment of toilet accessories.

B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

D. Floor-and-Ceiling-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

E. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at**[tops and]** bottoms of posts. Provide shoes**[and sleeves (caps)]** at posts to conceal anchorage.

F. Door Size and Swings: Unless otherwise indicated, provide 610-mm- wide in-swinging doors for standard toilet compartments and 914-mm- wide out-swinging doors with a minimum 813-mm-wide clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Pilasters and Panels: 1/2" (13 mm).

b. Panels and Walls: 1” (25 mm).

2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.

a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

3. Stirrup Brackets; where no-sightline systems are not required: Secure panels to walls and to pilasters with no fewer than **[two brackets attached] [three brackets attached at midpoint and]** near top and bottom of panel.

a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 51 mm into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

D. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.

E. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors**[and doors in entrance screens]** to return doors to fully closed position.

END OF SECTION 102113

SECTION 104415 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Portable fire extinguishers.
2. Fire-protection brackets and cabinets for extinguishers.

B. Application of Fire Extinguishers:

1. Provide fire extinguisher types, size, and placement in accordance with the OBO Building Code Chapter 9.
2. More specific indication of location and recessing may be identified in Drawings.

C. Related Sections:

1. Division 21 Sections on fire suppression system.
2. Section 284626 “Addressable Fire Alarm Systems.”

1.2 SUBMITTALS

A. Product data:

1. Fire Extinguishers: Include rating and classification.
2. Fire-Protection Cabinets: Product Data for each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Samples for Verification: For each type of exposed finish required, prepared on samples 150 by 150 mm square (6 by 6 inches) for review by the Project Director/COR.

C. Installation instructions.

D. Product Schedule: For fire-protection cabinets, indicate whether recessed, semi-recessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function. Fire-extinguisher schedule shall include the following: Serial/NEPA/Extinguisher Number, Manufacturer, Size, Type, Date of Manufacture or Hydrostatic Test, Property ID, Physical Location, Remarks, Inspection Date, and Inspector Name. **[Use same designations indicated on Drawings.]**

E. Operating and maintenance instructions.

1.3 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

C. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.4 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

C. Apply decals and vinyl lettering on field-painted fire-protection cabinets after painting is complete.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Operational Readiness: Delivery fully charged with all necessary components to be fully operational with breakaway seals in place.

B. Packaging: Each extinguisher shall be individually packaged in sturdy packaging designed to withstand normal shipping and handling without damage.

C. Storage: Store extinguishers in environmental conditions as recommended by manufacturer and in clean condition.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

1. Sheet: ASTM B 209M.
2. Extruded Shapes: ASTM B 221M.

C. Stainless-Steel Sheet: ASTM A 666, Type 304.

D. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 2 (tinted, heat absorbing, and light reducing), tint as indicated, or otherwise as selected by Project Director/COR.

2.2 PORTABLE FIRE EXTINGUISHERS

A. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

B. Manufacturer and Model: Ansul “Red Line” model.

1. For 4-A:40-B:C Rating, use RL-A-10-G cartridge with “Foray” powder.

C. Multipurpose Dry-Chemical Type: Industrial grade external cartridge operated multipurpose A-B-C portable dry chemical fire extinguishers. Extinguishers shall meet or exceed associated U.L. ratings identified.

1. 4-A:40-B:C Rating: 4.5 kg (10 lb.) nominal capacity.

a. Approximate Dimensions: 460 mm (18-1/8 in.) high; 210 mm (8-1/4 in.) wide; 130 mm (5-1/4 in.) deep.

D. Operation: Extinguisher activation and operation actions limited to:

1. Removal of safety ring pin.
2. Puncture of pressure cartridge to pressurize main canister.
3. Operation of discharge nozzle.

E. Approvals: Extinguishers shall meet or exceed approvals of Underwriters Laboratories (U.L.) or Underwriters Laboratories Canada (U.L.C), and the United States Coast Guard.

F. Inspection Capability: With the exception of internal inspection of pressure cartridges, extinguishers shall be designed and constructed to allow complete visual inspection of all internal and external components by disassembly without need for special knowledge or tools.

G. Maintainability: Extinguishers shall be designed to allow field recharging without the requirement for special tools or servicing equipment.

H. Inspection Tag: Provide with each unit.

I. Fabrication:

1. Main Canister Shell: Corrosion and impact resistant steel and painted with red paint resistant to cracking, chipping, and corrosion in harsh climates. Shell shall have fill port at top with opening of not less than 7 mm (2-3/4 inch) in diameter internally threaded to accommodate fill cap. Shell exterior shall incorporate device to secure discharge nozzle.
2. Pressure Cartridge: Cartridge shall contain noncombustible gas under pressure in amount appropriate for proper discharge of contents of main canister. Cartridge shall have clearly visible (when disassembled from unit) puncture seal to facilitate visual determination of cartridge condition (i.e., charged versus discharged). Cartridge shall be designed for installation and removal by hand only, without need for tools. Cartridge shall be provided with "left-hand" threads to prevent inadvertent installation of incorrect cartridges. Each cartridge shall have appropriate size designation clearly marked on body of cartridge. Enclose pressure cartridge with protective cover attached to side of main canister designed for easy removal.
3. Discharge Nozzle: Metal construction with access to internal discharge valve without use of special tools. Nozzle shall be designed to provide "On/Off'" operation with little effort on part of operator and designed and fabricated to operate in all environments.
4. Discharge Hose: Fabricate of long-lasting rubber resistant to climatic conditions and retain flexibility to –40 deg. F (-40 deg. C). All couplings shall be of corrosion resistant metal.
5. Carrying Handle: Configuration of handle shall be such that angle of unit while carried is appropriate for proper operation of unit.
6. Actuating Mechanism: Actuating lever shall be designed to require only single downward pushing action to activate pressure cartridge. All internal working parts of cartridge puncture mechanism shall be of stainless steel.
7. Fill Cap: Corrosive resistant metal and externally threaded to adapt to main canister. Threads shall include machined grooves perpendicular to threads to provide for release of internal pressure from main canister during removal while at least two full threads are still fully engaged. Fill cap shall be designed to be installed and removed by hand only without need for tools.

2.3 FIRE-PROTECTION CABINET

A. Cabinet Type: Where scheduled or indicated, provide for 4-A:40-B:C extinguisher, suitable for fire extinguisher.

B. Cabinet Construction: Fire-resistive rating in accordance with rating of associated wall. Where wall is fire-rated, fire-rated cabinets are only available as semi-recessed or recessed types.

C. Cabinet Material: Stainless-steel sheet.

D. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

1. Trimless with Plaster Stop: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as plaster stop.
2. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.

3. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend) of 6 to 8 mm.

E. Semi-Recessed Cabinet: Cabinet box recessed in walls of depth to suit style of trim indicated.

1. One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
2. Trim Type: As indicated on Drawings or as otherwise selected, and as follows:

a. Square-Edge Trim: 32- to 38 mm (1-1/4- to 1-1/2-inch) backbend depth.
b. Rolled-Edge Trim: 64-mm (2-1/2-inch) backbend depth.

F. Door Material: Steel sheet.

G. Door Style: Center glass panel with frame.

H. Door Glazing: Tempered float glass; see Article on MATERIALS.

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide continuous hinge, of same material and finish as trim**,** permitting door to open 180 degrees.

J. Accessories:

1. Internal Cabinet Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, with plated or baked-enamel finish.
2. Lettered Door Handle: One-piece, cast-iron door handle.
3. Provide cabinets without locks.
4. Identification: Lettering complying with “OBO Design and Wayfinding Design Guide” for style. Locate as indicated by Project Director/COR.

a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

5. Alarm: Manufacturer's standard alarm that actuates when fire-protection cabinet door is opened and that is powered by batteries or low voltage, complete with transformer.

K. Finishes:

1. Manufacturer's standard baked-enamel paint for the following:

a. Exterior of cabinet door, and trim, except for those surfaces indicated to receive another finish.
b. Interior of cabinet and door.

2. Stainless Steel: Satin, reflective, directional polish, No. 7.

2.4 MOUNTING BRACKETS

A. For extinguishers not specified to be placed in cabinets, provide brackets for mounting.

B. Brackets: Capable of supporting 16 kg (35 lb.) charged weight. Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, for size, type, and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

C. Identification: Lettering complying with “OBO Design and Wayfinding Design Guide” for style. Locate as indicated by Project Director/COR.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

2.5 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth.

1. Construct fire-rated cabinets with double walls fabricated from 1.1-mm- thick, cold-rolled steel sheet lined with minimum 16-mm- thick, fire-barrier material. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 13 mm thick.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine roughing-in for cabinets to verify actual locations before cabinet installation.

B. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.

C. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.

D. Prepare recesses for recessed or semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

E. Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

F. Mounting Height:

1. Minimum: 100 mm (4 inches) above finished floor.
2. Maximum: 1.5 m (5 feet) above finished floor.
3. Where applicable, mounting height shall conform to accessibility requirements for this Section.

G. Accessibility: Where applicable, conform to accessibility requirements in Chapter 11 of the OBO Building Code.

H. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness or design does not allow for fully recessed cabinets, provide semi-recessed cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
4. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
5. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair.

I. Extinguishers Mounted without Cabinets: For extinguisher types not specified to be placed in cabinet, install mounting brackets to surfaces, square and plumb, at locations indicated.

J. Identification: Apply decals and vinyl lettering at locations indicated.

END OF SECTION 104415

SECTION 105110 – CELL PHONE AND LAPTOP LOCKER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Lockers for cell phone, tablet, and laptop storage.

B. Related Requirements:

1. Section 262725 “Wiring Devices.”

1.3 ACTION SUBMITTALS

A. Product Data: Submit manufacturer’s printed data including materials, accessories, construction, finishes, assembly and installation instructions for lockers.

B. LEED Submittals:

1. For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.

C. Shop Drawings: Submit layout and dimensions of metal lockers. Indicate relationship to adjoining surfaces. Show locker elevations and details, fillers, trim, base, sloping tops, lock location, and accessories. Include locker numbering sequence. Indicate installation and anchorage requirements.

D. Samples: Submit 150-mm (6-inch) square metal samples of color and finish required for metal lockers finish.

E. Operating Instructions: Furnish government with one complete set of installation instructions, including special adjusting tools and maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Furnish one complete catalog for each manufacturer listed.

1.4 CLOSEOUT SUBMITTALS

A. Warranty: Submit specified warranty in accordance with Division 01 requirements.

B. Maintenance Data: For lockers specialties and finishes to be included in maintenance manuals in accordance with Division 01 requirements.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain locker units and accessories from one manufacturer.

B. Regulatory Requirements:

1. Comply with requirements of Chapter 11 of the OBO Building Code as applicable to accommodate barrier free design.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver lockers until spaces to receive them are clean, dry, and ready for locker installation. Protect lockers from damage during delivery,

1.7 FIELD CONDITIONS

A. Field Measurements: Verify the following by field measurements before fabrication and indicate measurements on Shop Drawings:

1. Concealed framing, blocking, and reinforcements that support metal lockers before they are enclosed.
2. Recessed openings.
3. Established Dimensions: Where field measurements cannot be made without delaying the work, establish recessed opening dimensions and proceed with fabricating metal lockers without field measurements. Coordinate wall and floor construction to ensure that actual recessed opening dimensions correspond to established dimensions.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below, ordered during initial procurement of materials to be installed, that match products installed and that are packaged with protective covering for storage and identified with labels describing content.

1. Metal locker hardware units equal to 10 percent of amount installed for each type and finish installed, but no fewer than five units:

a. Resettable combination lock.
b. Key paired to original product, if applicable.

c. Door and hinge assembly.
d. Identification plate.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of locker specialties that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation of hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal surface wearing.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CAA AREA CELL PHONE, TABLET, AND LAPTOP LOCKERS

A. Location: Provide outside entrances to controlled corridors serving the Controlled Access Area (CAA) where indicated in the drawings.

B. Quantity: Provide one locker per desk in the CAA served, plus 10 percent, rounding up to full unit.

C. Size: Each locker compartment must be sized with the following minimum dimensions (width x depth x height)

1. Cell Phone: 150 mm (6 inches) x 200 mm (8 inches) x 127 mm (5 inches)
2. Tablet/Laptop: 343 mm (13-1/2 inches) x 432 mm (17 inches) x 127 mm (5 inches)

D. Construction: Theft deterrent heavy gage steel construction.

E. Power:

1. Cell Phone (GWA): Each compartment must be equipped with a USB Type-C, 24-pin connector.
2. Cell Phone (Tenant): Where required by specific tenant agencies, each compartment must be equipped with a duplex receptacle.
3. Tablet/Laptop: Each compartment must be equipped with a duplex receptacle.

F. Finish: Baked enamel finish. Color: **<Insert color>**.

G. Labeling: Manufacturer's standard number plates.

H. Keying: Resettable combination lock

1. Keyless 3-digit combination lock with manual dial and master key.
2. Quantity of keys: Provide three master keys.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified locker installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lockers complete with accessories according to manufacturer's recommendations. Install plumb, level, rigid, and flush.

B. Anchor lockers at intervals recommended by manufacturer. Install anchors through back-up reinforcing plates where necessary to avoid metal distortion, using concealed fasteners.

C. Install recess trim to recessed lockers using concealed fasteners. Provide hairline joints and concealed splice plates.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust doors and latches to operate easily without binding. Verify that integral locking devices are operating properly.

B. Clean interior and exposed exterior surfaces and polish stainless-steel and nonferrous metal surfaces.

C. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit locker use during construction.

D. Touch up marred finishes or replace locker units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

3.4 DEMONSTRATION

A. Instruct Government's O&M personnel in proper adjustment and maintenance of the combination locks and hardware assemblies. Additionally, the field demonstrate repair and replacement of combination locks. Demonstration and Training must be provided in accordance with Division 01 specification requirements.

B. The following demonstration and training durations must be meet, at minimum:

1. Classroom: 30 minutes.
2. Field Demonstration: 30 minutes.

END OF SECTION 105110

SECTION 105613 - METAL STORAGE SHELVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Four-post metal storage shelving (FPMS) and accessories.
2. Cantilever racks and accessories.
3. Pallet Racks.
4. Storage cabinets.
5. Plan file stands.
6. Vertical Sheet Racks.

B. Related Sections include the following:

1. Division 10 Section on mobile storage shelving.
2. Division 10 Section on safety storage cabinets.
3. Division 12 Section on work benches.
4. **[Division 13 Section on modular mezzanines.]**
5. Section 271116 “Communications Cabinets and Frames” for racks used with telecommunications equipment.
6. Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks used with TSS.

1.2 PERFORMANCE REQUIREMENTS

A. [Delegated Design: For shelving units higher than 4500 mm (15 feet), design metal storage shelving, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.]

B. [Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>, and conform to seismic design requirements of the OBO Building Code (International Building Code as amended by OBO).

1. Seismic Component Importance Factor: 1.0.]

C. Structural Performance for Post-and-Shelf Metal Storage Shelving: Provide metal storage shelving capable of withstanding the loads indicated when tested according to MH 28.1, "Specification for the Design, Testing, Utilization and Application of Industrial Grade Steel Shelving."

D. Structural Performance for Post-and-Beam Metal Storage Shelving: Capable of withstanding the loads indicated according to MH 28.2.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.

B. Shop Drawings: For racks and other customized metal storage shelving. Include plans, aisle widths, elevations, sections, details, and attachments to other work. Include installation details of connectors, lateral bracing, and special bracing.

C. Samples for Verification: For the following components, of size indicated below.

1. Posts: 300 mm long.
2. Shelves: Full size, but not more than 600 mm wide by 300 mm deep.
3. Connectors: Full size.
4. Shelf Labels: Full size.

D. [Delegated-Design Submittal: For metal storage shelving indicated to comply with performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for seismic restraints.]

E. Qualification Data:

1. Installer.
2. **[Professional engineer in accordance with ASCE/SEI 7].**
3. **[Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.]**

F. Product Schedule: For metal storage shelving. Use same designations indicated on Drawings.

G. Product Certificates: For each type of metal storage shelving from manufacturer.

H. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain metal storage shelving through one source from a single vendor.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Vendor’s Qualifications for Rack Design: Minimum five years experience with similar warehouse applications. Vendors shall review rack layout and accessories to confirm and maximize rack design and storage capacity.

D. [Engineer Responsibility: A professional engineer shall design the seismic restraints for shelves, cabinets and files. Engineer shall have experience in design of seismic restraints for similar projects using similar products, equipment and installation design. Manufacturer may submit evidence that seismic restraints systems and installation requirements have been written and reviewed by an engineer on staff.]

E. [Product Options: Drawings indicate size, profiles, and dimensional requirements of metal storage shelving and are based on the specific system indicated.

1. Do not modify structural and operational performance.]

F. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver metal storage shelving palleted, wrapped, or crated to provide protection during transit and Project-site storage.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weatherproof, wet work in spaces is completed and dry, and ambient temperature is being maintained at the levels indicated for Project when occupied for its intended use.

1.7 COORDINATION

A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to partition assemblies.

B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, and sprinklers.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Shelves: Full-size units equal to 15 percent of amount installed for each type indicated, but no fewer than 10 shelves.
2. Shelf-to-Post Connectors: Full-size units equal to 15 percent of amount installed for each type indicated, but no fewer than 10 connectors.
3. Shelf Labels: Equal to 25 percent of amount installed for each type indicated.
4. Plan Racks: Provide additional 24 plan rack clamps for drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

C. Steel Tubing: ASTM A 513, Type 2.

D. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.

E. Floor Anchors: Galvanized-steel, power-actuated fasteners. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.

F. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide [**one**] <**Insert number**> per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

2.2 FOUR-POST METAL STORAGE SHELVING (FPMS)

A. Four-Post Metal Storage Shelving: This shelving type may be identified in some instances as simply “Steel Shelves” or “Storage Shelving” (e.g., at Shop spaces). Factory-formed, field-assembled, freestanding, post-and-shelf metal storage shelving system; designed for shelves to span between and be supported by corner posts, with shelves adjustable over the entire height of shelving unit. Fabricate initial shelving unit with a post at each corner. Fabricate additional shelving units similarly, so each unit is independent. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated. Provide open shelving except where indicated otherwise.

1. Available Manufacturers: Manufacturers providing four-post metal storage shelving include, but are not limited to:

a. Adjustable Shelving Products; a division of Karp Associates, Inc.
b. Borroughs Corporation.
c. Edsal.
d. Equipto.
e. Excalibur Shelving Systems.
f. Hallowell; Division of List Industries, Inc.
g. Hodge; a division of Durham Mfg. Co., Inc.
h. Jeter Systems Corporation.
i. Lyon Workspace Products, LLC.
j. Montel Aetnastak Inc.
k. Penco Products, Inc.
l. Richards-Wilcox, Inc.
m. Rousseau Metal Inc.

n. Safco Products; a division of LDI.
o. Schaefer Systems International, Inc.
p. Shelf Esteem Inc.
q. Spacesaver Corporation.
r. Tennsco.
s. Unicor; Federal Prison Industries, Inc.
t. Western Pacific Storage Systems.

B. Structural Performance for Four-Post Metal Storage Shelving: Provide metal storage shelving capable of withstanding the loads indicated when tested according to MH 28.1, "Specification for the Design, Testing, Utilization and Application of Industrial Grade Steel Shelving."

1. Load-Carrying Capacity per Shelf: 680 kg (1500 lb) for typically loaded shelves.

C. Construction

1. Posts: Fabricated from hot rolled steel in manufacturer's standard shape; with perforations at 40 mm o.c. (1-1/2 inches o.c.) to receive shelf-to-post connectors.

a. Add-On Shelf Posts: Fabricated from hot-rolled steel, T-shaped; perforated to match main posts and same thickness.
b. Post Base: Adjustable steel foot plate, drilled for mechanical attachment to floor.

2. Bracing: Manufacturer's standard double diagonal cross bracing at back and ends, as required for stability and load-carrying capacity.
3. Solid-Type Shelves: Fabricated from steel sheet.

a. Steel-Sheet Thickness, Nominal: Of thickness required for load-carrying capacity per shelf.

4. Framed-Type Wire Shelves: Steel in locations with low-level corrosion or pollution risk, or stainless steel in locations with moderate or extreme corrosion or pollution risk.
5. Shelf-to-Post Connectors: Manufacturer's standard connectors.
6. Base: Open, with exposed post legs.
7. Steel Finish: Baked enamel or powder coat.

a. Color and Gloss: As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range.

D. Accessories:

a. Label Holders: Clear plastic, designed to clip onto front edge of shelf.
b. Drawers: Where indicated or scheduled.
c. Doors: Where indicated or scheduled.
d. Storage Basket: Where indicated, Edge-of-shelf-mounted wire basket, <**Insert dimensions**>; fabricated from same material and with same finish as shelves.
e. [Rolling Ladders: For FPMS with 3600 mm (144 inches) height.]

2.3 CANTILEVER RACKS

A. Cantilever Rack, I-Beam - Metal Storage Shelving (OBO Component Code FS082): Factory-formed, field-assembled, cantilever rack metal storage shelving system shall be double sided upright. Single sided sections shall have similar design requirements.

1. Available Manufacturers: Manufacturers providing cantilever rack metal storage shelving include, but are not limited to:

   a. Lyon Metal Products, Inc.
   b. Redirack Storage Systems
   c. Steel King Industries, Inc.

2. Load-Carrying Capacity of Upright: **[XX kg (XX lbs)].**
3. Uprights:

   a. Provide three uprights per 2400 mm length of initial floor run of shelving units, two additional uprights per each additional 2400 mm length of floor run.

4. Columns: Factory-welded to base.
5. Arms:

   a. Cantilever arms shall be 1200 mm (48 inches) in length, unless indicated otherwise in specific locations.
   b. Adjustable vertically in 75 mm (3 inch) increments.
   c. Arm Configuration: Straight arms, except where indicated or scheduled as sloped (angled) arms. Arms shall be steel I beam construction with fastening points for grate decking.
   d. Capacity: 700 kg (1,540 pounds) minimum.

6. Bracing: Manufacturer's standard between uprights.
7. Decking: Steel grating, self-supporting, of minimum of 1400kg (3080 pounds) weight capacity. Secure grating to cantilevered arms using bolts or other manufacturer recommended fasteners. Openings in grating shall not exceed 25mm by 100 mm (1 inch by 4 inches), with smaller opening pattern preferred if available.
8. Nominal Height of System:

   a. Expendable Storage: Where cantilevered racks are scheduled for expendable storage, provide 1800 mm (6 ft) high units.
   b. [Low-Bay: [3650 mm (12 ft).]
   c. [High-Bay: [5500 mm (18 ft).] [6700 mm (22 ft)] to top of deck.]

9. Colors: Selected by Project Director/COR, based on input from the A/E of Record, from manufacturers standard colors.
10. Accessories:

    a. Label Holders: Clear plastic, designed to clip onto front edge of shelf.

B. Cantilever Rack, Horizontal - Metal Storage Shelving (OBO Component Code SQ021): Factory-formed, field-assembled, light-duty cantilever rack metal storage shelving system.

1. Load-Carrying Capacity per Arm: 227 kg (500 lbs.).
2. Material: 2.75 mm (12-gauge) steel with electrostatically-coated powder paint finish.
3. Arm Length: 610 mm (24 inches).
4. Arm Type: Single with lip; adjustable on 38 mm (1-1/2 inch) increments.
5. Lip: 63 mm (2-1/2 inches).
6. Colors: Selected by Project Director/COR, based on input from the A/E of Record, from manufacturers standard colors.

C. Cantilever Rack, Heavy Duty - Metal Storage Shelving (OBO Component Code SQ090): Factory-formed, field-assembled, cantilever rack heavy duty metal storage shelving system shall include increased gauge of hardware to meet prescribed weight limits of storage needs.

2.4 PALLET RACKS (OBO COMPONENT CODE FS083):

A. Pallet Rack Metal Storage Shelving: Factory-formed, field-assembled, metal rack storage shelving system consisting of two each, two-post cross-braced vertical units, connected by horizontal load-carrying beams front and rear.

1. Available Manufacturers: Manufacturers providing pallet rack metal storage shelving include, but are not limited to:

   a. Lyon Metal Products, Inc.
   b. Redirack Storage Systems
   c. Steel King Industries, Inc.

2. Load-Carrying Capacity of Vertical Uprights: **[12,700 kg (28,000 lb.)]**.
3. Uprights: Bolt to floor front and rear.

   a. Provide two uprights for first section, one upright for each additional section, per row of racking.
   b. Tear drop fastening system adjustable at 50 mm (2 inches) o.c.

4. Beams: Rolled form steel with integrated step for decking, and three or four attaching stud pins with safety lock mechanism.

5. Beam Length: **[2400 mm (8 ft)] [2700 mm (9 ft)] [3000 mm (10 ft)] [3600 mm (12 ft)]**.
6. Beam Capacity: **[1400 kg (3000 lbs)] [2000 kg (4500 lbs)]**.
7. Anti-Ram Guards: Provide at rack end posts.
8. Decking: Waterfall type, hooking over front and rear of horizontal support beams. Provide "U" or inverted "U" channels in lieu of flared-end channels for support of decking. One "U" channel support per linear foot of decking.
9. Nominal Height of System:

   a. [Low Bay: [3650 mm (12 ft)] [4500 mm (15 ft)] to top of deck.]
   b. [High Bay: [5500 mm (18 ft)] [6700 mm (22 ft)] to top of deck.]

10. Stack Depth: 1220 mm (48 inches), unless indicated otherwise in specific locations.
11. Colors: Selected by Project Director/COR, based on input from the A/E of Record, from manufacturers standard colors.
12. Accessories:

    a. Label Holders: Clear plastic, designed to clip onto front edge of shelf.

2.5 STORAGE CABINETS

A. Storage Cabinets: This cabinet type may be identified in some instances as simply "Cabinet Storage, Cabinet Safety Equipment Storage, Metal Cabinet Storage or Lockable Cabinet Storage." Steel with baked enamel finish and shall include a recessed handle with build-in lock and two keys; three hinges per door and three point latching. Shelves shall be adjustable at 50 mm (2-inch) intervals and shall be capable to support a minimum 180 kg (400 pounds) per shelf. Doors shall open a full 180 degrees.

1. Available Manufacturers: Manufacturers providing cabinets include, but are not limited to:

    a. Lyon Metal Products Inc.
    b. Penco Products Inc.
    c. Richards-Wilcox, Inc.

B. General: Provide cabinets where indicated or scheduled.

1. Max. Unit Width: 900 mm (36 inches).

C. Colors: Selected by Project Director/COR, based on input from the A/E of Record, from manufacturers standard colors.

2.6 MOBILE PLAN RACK (OBO COMPONENT CODE FN114):

A. General: Self-contained stand that can hold up to 1200 prints.

1. Basis of Design: Safco Products Company, Model 5026.

B. Stand: Adjustable from 1075 mm (43 inches) to 1525 mm (61 inches) for sheets up to 1375 (54 inches) long.

C. Base: Extends 675 mm (27 inches) to 925 mm (37 inches) wide to accommodate various size drawings.

D. Steel construction with four ball-bearing swivel casters, with 2 casters that lock; minimum of 12 pivot brackets per rack.

1. Color: Tropical Sand, or as selected by Project Director/COR, based on input from the A/E of Record, from manufacturers standard colors.

E. Hanging Clamps: Extruded aluminum clamps with polished chrome-plated cast alloy wing knobs. Provide 12 clamps to fit on the pivot brackets in lengths to accommodate prints up to 900 mm (36 inches) wide.

2.7 SHEET RACK – VERTICAL (OBO COMPONENT CODE SQ038):

A. Sheet Storage Rack: Factory-formed, field-assembled, metal rack storage shelving system consisting of four storage bays at 180 mm (7 inches) width each. Upright dividers shall be adjustable at 50 mm (2-inch) intervals and shall be capable to support a minimum 2,720 kg (6,000 pounds) total capacity. Minimum upright divider height shall be 685 mm (27 inches) and maximum shall be 1060 mm (42 inches).

1. Available Manufacturers: Manufacturers providing sheet storage racks include, but are not limited to:

a. Lyon Metal Products Inc.
b. Little Giant Inc.
c. GAV, Inc.

B. General: Provide racks where indicated or scheduled.

1. Overall Unit Width: 1220 mm (48 inches).
2. Overall Unit Depth: 900 mm (36 inches).
3. Overall Unit Height: 1120 mm (44 inches).

C. Colors: Selected by Project Director/COR based on input from the A/E of Record from manufacturers standard colors.

2.8 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Fabricate metal storage shelving square and rigid with posts plumb and true, and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a 13-mm- wide hem on the concealed side; ease edges of metal plate to radius of approximately 1.0 mm.

E. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Weld corners and seams continuously to comply with referenced AWS standard and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
5. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

G. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.

H. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.

I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

J. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

2.9 GENERAL FINISHES REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 STEEL FINISHES

A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry thickness.

1. Color and Gloss: As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine floors for suitable conditions where metal storage shelving will be installed.

C. Examine walls to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Vacuum finished floor over which metal storage shelving is to be installed.

3.3 INSTALLATION

A. Install metal storage shelving level, plumb, square, rigid, and true, and within erection tolerances specified.

1. Anchor shelving units to floor with suitable fasteners through foot plate. Shim foot plate as required to achieve level and plumb installation.
2. Connect side-to-side and back-to-back shelving units together at corner posts with support ties.
3. Install shelves in each shelving unit at spacing indicated on Drawings or, if not indicated, at equal spacing.

a. Four-Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf; with clips fully engaged in post perforations.

4. [Brace shelving units as required for seismic forces.]

B. Pallet Racks:

1. Place 150 mm (6 inches) from wall or 300 mm (12 inches) apart if back-to-back, using Manufacturer's standard bracing between rack and walls, and between back-to-back units.

C. Accessories:

1. Shelf Labels: Install one shelf label at each shelf, centered within each shelving unit.
2. Back Ledges: Install one back ledge per shelf.
3. Side Ledges: Install side ledges at each side of each shelf.

3.4 ADJUSTING AND CLEANING

A. Verify that shelves and shelf-to-post connectors adjust easily and properly.

B. On completion of installation, clean exposed surfaces as recommended by manufacturer.

C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.

D. Replace metal storage shelving that has been damaged or has deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 105613

SECTION 105640 – SAFETY STORAGE CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Flammable storage cabinets.

1.2 SUBMITTALS

A. Product Data: Include capacity and dimensions, construction details, required features, material descriptions, and finishes for cabinets.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of safety storage cabinet through one source from a single manufacturer.

B. NFPA, OSHA, and Code Compliance: Comply with NFPA 30 and OSHA 29 CFR 1910.106. Comply with the OBO Fire Code.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver cabinets palleted, wrapped, or crated to provide protection during transit and Project-site storage.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until spaces are enclosed and weatherproof, wet work in spaces is completed and dry, and ambient temperature is being maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eagle Manufacturing Company
2. Justrite Mfg. Co., LLC
3. Securall/A&A Sheet Metal Products

2.2 FABRICATION

A. Approximate Capacity and Size:

1. Standard: Storage, Cabinet Safety Equipment (OBO Component Code FN078):

   a. 170 liters (45 gallons).
   b. Provide two intermediate adjustable shelves supported by four brackets.

2. Small: Cabinet, Flammable Safety (OBO Component Code FN030): Provide in MED Suite where indicated on Construction Drawings.

   a. 15 liters (4 gallons).
   b. Provide one intermediate shelf supported by four brackets.

B. 1.3 mm (18 gauge) min. thick steel interior and exterior walls separated by 40 mm (1-1/2 inch) insulated air space.

C. Fully welded construction. Riveting is not permitted.

D. Vents: Provide two vents with flash arresters. Locate on opposite sides of cabinet.

E. Catch Pan: Provide 50 mm (2 inch) catch pan at bottom of cabinet to hold spills.

F. Feet: Provide adjustable feet to facilitate leveling. Cabinet sides may either cover feet, or feet may be exposed under cabinet.

G. Grounding: Built-in grounding connector for easy grounding.

H. Self-Closing Door. Manual closing is not permitted.

I. Locks: Three-point latch. Provide two sets of keys serving standard cabinets**[and two sets serving small cabinets]**.

J. Warning Label: Provide large warning label with words “FLAMMABLE – KEEP FIRE AWAY” in English, and Host Country language.

2.3 FINISHES, GENERAL

A. Finish all steel surfaces, inside and out, with powder coat or 2-coat high gloss powder paint finish.

1. Color: Safety yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine floors for suitable conditions where cabinets will be installed.

C. **[Examine walls to which cabinets will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.]**

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Vacuum finished floor over which cabinets are to be installed.

3.3 INSTALLATION

A. Install cabinets level and plumb.

3.4 CLEANING

A. Shortly before Substantial Completion, clean exposed surfaces as recommended by manufacturer.

END OF SECTION 105640

SECTION 111126 – VEHICLE WASHING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes vehicle washing equipment.

1.2 SUBMITTALS.

A. Product Data: Submit manufacturer's product information and specifications and installation instructions for each item of equipment furnished.

B. Roughing-In Drawings: Provide roughing-in drawings for mechanical and electrical services.

C. Shop Drawings: Provide drawings showing, in large scale, methods of construction, joining, dimensions, materials, thicknesses, finishes of materials, installation, relation to adjoining work, and all other details to fully illustrate the work.

D. Connection Drawings: Submit complete electrical, plumbing, and mechanical connection information and coordinate with Divisions 22, 23, and 26.

E. Maintenance and Operation Manuals: Provide manufacturer's maintenance and operation manuals.

1.3 QUALITY ASSURANCE

A. Single Subcontract Responsibility: Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of products that are of a similar material, design, and workmanship.

B. Nameplates: Each major item of equipment shall have the manufacturer's name, address, and catalog or serial number permanently affixed to a plate securely attached to the equipment.

C. Verification of Dimensions: Contractor shall become familiar with all details of the work, verify all dimensions in the field.

1.4 DELIVERY AND STORAGE

A. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 WARRANTY

A. Wash Water Recycle System Warranty: Provide warranty for materials and installation;

1. Warranty Period: Two years from Substantial Completion.
2. Installer's Warranty: Two years from Substantial Completion.

B. Vehicle Wash Pressure System Warranty: Provide warranty for materials and installation;

1. Warranty Period: Seven years from Substantial Completion.
2. Installer's Warranty: Two years from Substantial Completion.

1.6 EXTRA MATERIALS

A. The following spare parts shall be supplied by manufacturer of treatment system as spare parts for operation of system:

1. Two AQAM Media: AQM-4.
2. Two Filter Bag Cases: BAG-20-C25.
3. Two EnBio-5 Pails: 19 L (5 gallon) each.
4. Two EBD Soap Pails: 19 L (5 gallon) each.

PART 2 - PRODUCTS

2.1 VEHICLE WASH WATER RECYCLE SYSTEM

A. Description: Provide a complete operational 0.63 L/s (10 gpm) wash water recycle system comprised of collection tanks, pumps, water treatment and controls as described herein. System to be installed in accordance with manufacturers written instructions.

B. Electrical: Manufacturer to provide electrical systems to operate on electrical system at the facility. System to be installed in accordance with manufacturer's written instructions.

C. Basis of Design: Pan American Environments. Equal systems by other manufacturers are acceptable **[Provide in host country voltage].**

1. Automated Wash Water Treatment System; model VEW-4-A; pump = 1/2HP, control NEMA 4..
2. FRP Triple Basin Collection Sump; model TB-3084; (requires water connections DN100 (4 inch) fittings, DN50 (2 inch) vent); sludge filter SF-D; level switches LS-EFF and LS-HH.
3. Automated Influent Feed System with progressive cavity pump and motor drive; model IFS-05-AO.
4. Automated Pressurixation Supply Module; model PSM-8.10-300.
5. Aeration Injection and Bacteria Removal System; model SuperAerator XL.

2.2 VEHICLE WASH PRESSURE WASHER

A. Description: Provide a complete operational 0.25 L/s (4 gpm), 2000 psi wall mounted pressure washer system comprised of pressure generator with stainless steel cabinet, 15 meters (50 feet) of DN10 (3/8 inch) high strength high pressure delivery hose and multi directional hose wand as described herein. Supply water to the unit shall be provided by the vehicle wash water recycle system. Manufacturer to provide electrical components compatible with the electrical system at the facility. System to be installed in accordance with manufacturers written instructions.

B. Basis of design shall be model Model SEA 4-200 24 with wall mount bracket by Landa Cleaning Systems. Equal systems by other manufacturers are acceptable. **[Provide in host country voltage]**.

2.3 OVERHEAD HOSE SUPPORT BOOM

A. Description: Provide an overhead high pressure hose support boom. Unit shall be constructed of stainless steel and provide a 360 degree overhead support for high pressure hose and wand.

B. Basis of design shall be model 204 by Zierco Waterboy, or equal. Coordinate assembly and mounting parts with site specific support structure

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the substrates, adjoining construction and conditions under which the Work is to be installed. Do not proceed with the Work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.

3.2 PREPARATION

A. Verify dimensions of supporting structure by field measurements so that equipment work will be accurately designed, fabricated and fitted to the structure. Examine roughed-in mechanical and electrical services, installation of floors, walls, columns, and ceilings, and other conditions under which medical equipment work is to be installed. Notify Contractor in writing, of any dimensions found to be different than shown. Use Contractor's benchmarks as basis of measurements.

3.3 INSTALLATION, GENERAL

A. Coordinate equipment work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work. Furnish installation templates, diagrams, and other data to fabricators and installers of related work as necessary for coordination of the installation. Place such items, including pipes, conduit, inserts and anchors, accurately in relation to the final location of equipment components.

B. Install all components of the equipment in accordance with the manufacturer's written instructions and recommendations.

C. Verify plumbing, ventilation and electrical connection requirements for all equipment with manufacturer and coordinate connections with Division 22, 23, and 26 work.

3.4 CLEANING

A. After completion of installation and other major construction work in equipment areas, remove protective coverings, if any, and clean equipment, internally and externally. Restore exposed and semi-exposed finishes to remove abrasions and other damages; and touch-up painted surfaces. Replace work that cannot be successfully restored.

B. Final Cleaning: After testing and start-up, and before time of Substantial Completion, clean and sanitize medical equipment, and leave in condition ready for use in medical service.

3.5 DEMONSTRATION AND TRAINING

A. Engage technician, factory-trained on equipment being installed, to demonstrate and train Government's maintenance personnel to adjust, operate, and maintain the vehicle washing equipment. Provide minimum of two 4-hour training sessions, with each session held at a distinctly different time period to accommodate personnel identified by Project Director/COR based on input from Post's Facility Manager.

B. Training sessions shall include classroom review of operations and maintenance manuals, shop drawings, and operational testing procedures.

C. Training sessions shall also include field or "hands-on" operating, testing, and maintenance procedures in the as-built system environment.

END OF SECTION 111126

SECTION 111305 - LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Loading dock bumpers.
2. Recessed loading dock levelers.
3. Stationary loading dock lifts (scissor lifts).

B. Related Requirements:

1. Section 055005 "Metal Fabrications" for **[curb angles at edges of recessed pits] [and] [loading dock platform edge channels]**.

1.2 DEFINITIONS

A. Operating Range: Maximum amount of travel above and below the loading dock level.

B. Working Range: Recommended amount of travel above and below the loading dock level for which loading and unloading operations can take place.

1.3 COORDINATION

A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation

B. Coordinate installation of cast-in-place items. Furnish setting drawings and templates.

C. Electrical System Roughing-in: Coordinate layout and installation of loading dock equipment with connections to power supplies**[and interlocked equipment]**.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of loading dock equipment.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for stationary loading dock equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For stationary loading dock equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of anchors and each field connection.

3. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Product Test Reports: For each dock leveler, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Indicate compliance of dock levelers with requirements in MH 30.1 for determining rated capacity based on comprehensive testing within last two years of current products.
2. Submittal Form: According to MH 30.1.

D. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For stationary loading dock equipment to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

C. Comply with requirements of the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with stationary loading dock equipment, including **[recessed pit dimensions] [slopes of driveways] [and] [heights of loading docks]**, by field measurements before fabrication.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace dock levelers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including cracked or broken structural support members, load-bearing welds, and front and rear hinges.
b. Faulty operation of operators, control system, or hardware.
c. Deck plate failures including cracked plate or permanent deformation in excess of 6 mm between deck supports.
d. Hydraulic system failures including failure of hydraulic seals and cylinders.

2. Warranty Period for Structural Assembly: 10 years from date of Substantial Completion.
3. Warranty Period for Hydraulic System: Five years from date of Substantial Completion.
4. Warranty shall be for unlimited usage of leveler for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 LOADING DOCK BUMPERS

A. General: Surface-mounted bumpers; of type, size, and construction indicated; designed to absorb kinetic energy and minimize damage to loading dock structure.

B. Laminated-Tread Loading Dock Bumper <**Insert drawing designation**>: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 19-mm- diameter, steel supporting rods that are welded at one end to 6-mm- thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 25 mm of tread plies extending beyond the face of closure angles.

1. Thickness: **[112 mm] [150 mm] [As indicated on Drawings] <Insert dimension>**.
2. Horizontal Style: **[150 mm] [250 mm] [300 mm] high by [length indicated on Drawings] <Insert dimension>**.
3. Vertical Style: 200 mm wide by **[500 mm high] [500 mm high] [900 mm high] [height indicated on Drawings] <Insert dimension>**.

C. Molded-Rubber Loading Dock Bumpers <**Insert drawing designation**>: Fabricated from molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Shore A durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240; of size and configuration indicated. Fabricate units with not less than two predrilled anchor holes.

1. Configuration: **[T shape] [Inverted-L shape] [Square] [Rectangular] [As indicated on Drawings] <Insert configuration>**.
2. Thickness: **[50 mm] [75 mm] [100 mm] [150 mm] [As indicated on Drawings] <Insert dimension>**.

D. Anchorage Devices: Galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated. Hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329/F 2329M.

E. Materials: ASTM 36/A 36M for steel plates, shapes, and bars. Hot-dip galvanize according to ASTM A 123/A 123M.

2.2 RECESSED LOADING DOCK LEVELERS <INSERT DRAWING DESIGNATION>

A. Standard: Comply with MH 30.1**[, except for structural testing to establish rated capacity]**.

B. Rated Capacity: Capable of supporting total gross load of **[9000] [11 000] [13 000] [20 000]** <**Insert load**> kg without permanent deflection or distortion.

C. Platform: Not less than **[5-] [6-] [9.5-]** <**Insert dimension**> mm- thick, nonskid steel plate.

1. Platform Width: **[1800 mm] [1950 mm] [2100 mm] [As indicated on Drawings] <Insert dimension>**.
2. Platform Length:**[1800 mm] [2400 mm] [3000 mm] [As indicated on Drawings] <Insert dimension>**.

3. Frame: **[Manufacturer's standard] [Clean-pit type, designed to support leveler at sides of pit, with no supports at front of pit floor]**.
4. Toe Guards: Equip open sides of dock leveler over range indicated with steel toe guards.

a. Toe-Guard Range: Entire upper **[operating] [working]** range.

D. Hinged Lip: Not less than **[13-] [16-] [19-] [25-]** <**Insert dimension**> mm- thick, nonskid steel plate.

1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube**[and grease fittings]**, with gussets on lip and ramp for support.

2. Safety Barrier Lip: Designed to protect material-handling equipment from an accidental fall from loading platform edge of the dock leveler when the leveler is not in use.

E. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:

a. Above Adjoining Platform: **[300 mm] [450 mm] [As indicated on Drawings] <Insert dimension>**.
b. Below Adjoining Platform: **[300 mm] [350 mm] [As indicated on Drawings] <Insert dimension>**.

2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to 102 mm over width of ramp.

4. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.

a. Length of Lip Extension: Not less than 300 mm from face of dock bumpers and not less than[400 mm] [450 mm] [500 mm] [dimension indicated on Drawings] <Insert dimension> measured from ramp edge.

5. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs.

6. Interlock: Leveler does not operate while **[overhead door is in closed position] [leveler night lock is engaged] [truck restraint is not engaged] [inflatable dock seal is not inflated] [and] [inflatable dock shelter is not inflated] <Insert equipment and condition>**.

F. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with an upward-biased-spring counterbalancing mechanism controlled by a hold-down device. Ramp raises to top limit of operating range by operating recessed control handle in ramp to disengage hold-down device. Ramp lowers below platform level with lip retracted by operating auxiliary, recessed control handle to release support legs.

1. Free-Fall Protection: Manufacturer's standard protection system to limit free fall of loaded ramps with front edge supported by truck bed.

G. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than 75 mm.

1. Remote-Control Station: **[Weatherproof single] [Single]**-button station of the constant-pressure type, enclosed in NEMA ICS 6, **[Type 4] [Type 12]** <**Insert type**> box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
2. Remote-Control Station with Emergency Stop: **[Weatherproof multibutton] [Multibutton]** control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, **[Type 4] [Type 12]** <**Insert type**> box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

   a. Dual-Panel Control Station: Remote-control station for operating side-by-side dock levelers.

   b. Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.

3. Independent Lip Operation: Electric-powered hydraulic raising and hydraulic lowering of lip, controlled independent of raising and lowering of ramp.

H. Electric Operating System: Electric control from a remote-control station; motorized operation. Electric activation for raising of ramp and automatic extending of lip. Equip leveler with a packaged unit including a unitized electric motor and shaft assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers.

1. Remote-Control Station: **[Weatherproof single] [Single]**-button station of the constant-pressure type, enclosed in NEMA ICS 6, **[Type 4] [Type 12]** <**Insert type**> box. Ramp

raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.

2. Remote-Control Station with Emergency Stop: **[Weatherproof multibutton] [Multibutton]** control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, **[Type 4] [Type 12]** <**Insert type**> box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. Ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.

I. Air-Bag Operating System: Electric control from a remote-control station; pneumatic operation. High-volume, low-pressure lifting of ramp. Equip leveler with a packaged unit including a PVC-coated, reinforced polyester lifting bag and two-stage, single-speed electric fan of proper size, type, and operation for capacity of leveler indicated. Include dock-leveler supports controlled by release chain for lowering ramp below platform level without extending lip.

1. Remote-Control Station: **[Weatherproof single] [Single]**-button station of the constant-pressure type, enclosed in NEMA ICS 6, **[Type 4]** <**Insert type**> box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.

J. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.

1. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.
2. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.

K. Materials:

1. Steel Plates, Shapes, and Bars: ASTM 36/A 36M.
2. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 380.
3. Steel Tubing: ASTM A 500/A 500M, cold formed.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

L. Dock-Leveler Finish: **[Manufacturer's standard prime-paint or baked-on factory finish] [Hot-dip galvanized] [Spray zinc metallized] <Insert requirements>**.

1. Toe Guards: Baked-on factory finish.

M. Accessories:

1. Curb Angles: 75-by-75-by-6-mm galvanized-steel curb angles for edge of recessed leveler pit, with 13-mm- diameter by 150-mm- long concrete anchors welded to angle at 150 mm o.c.

2. Self-Forming Pan: Manufacturer's standard prefabricated, self-forming**[spray zinc metallized]** steel form system for poured-in-place construction of concrete pit.
3. Night Locks: Manufacturer's standard means to prevent extending lip and lowering ramp when overhead doors are locked.
4. Side and rear weatherseals.
5. Foam insulation under dock-leveler platform.
6. **[Abrasive skid-resistant] [Smooth]** surface.

2.3 STATIONARY LOADING DOCK LIFTS <INSERT DRAWING DESIGNATION>

A. General: Stationary, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.

B. Standard: MH 29.1.

C. Rated Capacity: Lifting capacity of not less than **[3500 kg)] [load indicated on Drawings]** <Insert requirements> with axle loads of **[3000 kg at ends and 2250 kg at sides] [magnitudes indicated on Drawings] <Insert requirements>**.

D. Platform: **[Nonskid, safety-tread] [Smooth-surface]** heavy**[hot-dip galvanized-]** steel deck plate.

1. Platform Size: **[1800 mm long by 1800 mm wide] [2400 mm long by 1800 mm wide] [3000 mm long by 1800 mm wide] [As indicated on Drawings] <Insert size>**.

2. Platform Guarding: **[Bevel toe guards] [Toe sensor] [Indicator bar] [Skirts] [Enclosure]** to comply with requirements in MH 29.1

3. **[Removable] [Fixed]** Guard Rails: Provide **[steel] [hot-dip galvanized-steel] [aluminum]** guard rails on two sides of platform with a single, removable chain across each end. Provide guard rails not less than 975 mm (39 inches) high with midrail and 100-mm- high, kick plate at bottom.**[Mount rail sockets flush with platform surface.]**

E. Bridge: **[Nonskid, safety-tread steel] [Nonskid, safety-tread, hot-dip galvanized-steel] [High-tensile aluminum]** plate.

1. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.

2. Size: **[450 mm long by 1500 mm wide] [450 mm long by 1800 mm wide] [As indicated on Drawings] <Insert size>**.
3. Locations: **[Ends] [Sides] [As indicated on Drawings]**.

F. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.

1. Vertical Travel and Travel Speed: As indicated on Drawings.

2. Vertical Travel: Maximum of **[1500]** <**Insert dimension**> mm from a lowered height of **[300]** <**Insert dimension**> mm for a total raised height of **[1800]** <**Insert dimension**>mm.

3. Travel Speed: Nominal raising speed of **[0.04 (8)] [0.05 (10)] [0.06 (12)]** <**Insert speed**>m/s (fpm).

4. Hinged Throw-over Bridge Operation: **[Manual] [Spring assist] [Manual-assist bridge winch] [Automatic powered]**.

G. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.

1. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.

a. Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
b. Equip reservoir, valve manifold, and pressure line with oil-line filters.

2. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement-plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.

a. Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.

3. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, **[Type 12]** <**Insert type**> box.

a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.

H. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.

1. Scissors Mechanism: Fabricate leg members from heavy, hot-dip galvanized- steel-formed tube or plate members to provide maximum strength and rigidity.

2. Scissors Configuration: **[Single leg] [Multiple width] [Multiple length]**.
3. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
4. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.
5. Mounting: **[Surface] [Pit]**.

I. Materials:

1. Steel Plates, Shapes, and Bars: ASTM 36/A 36M.
2. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 380.
3. Steel Tubing: ASTM A 500/A 500M, cold formed.

J. Dock Lift Finish: Manufacturer's standard baked-on factory finish unless otherwise indicated.

2.4 FINISH REQUIREMENTS

A. Finish loading dock equipment after assembly and testing.

B. Hot-Dip Galvanizing: Comply with the following:

1. ASTM A 123/A 123M for iron and steel loading dock equipment.
2. ASTM A 153/A 153M or ASTM F 2329/F 2329M for iron and steel hardware for loading dock equipment.

C. Spray Zinc Metallizing: ASTM B 833.

D. Electrodeposited Zinc Coatings: ASTM B 633.

E. Steel Prime Paint Finish: Clean, pretreat, and apply manufacturer's standard primer.

F. Baked-on Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

1. Color: **[Manufacturer's standard] [Match Project Director/COR's sample] <Insert color>**.
2. Toe Guards: Paint to comply with ANSI Z535.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.

C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.

B. Set curb angles in concrete edges of truck-leveler recessed pits with tops flush with driveway. Fit exposed connections together to form hairline joints.

C. Place self-forming pan system for **[recessed dock] [edge-of-dock]** levelers in proper relation to loading platform before pouring concrete.

D. Clean recessed pits of debris.

3.3 INSTALLATION, GENERAL

A. Install loading dock equipment as required for a complete installation.

1. Rough-in electrical connections.

3.4 INSTALLATION OF LOADING DOCK BUMPERS

A. Loading Dock Bumpers: Attach loading dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.

1. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
2. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
3. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.

3.5 INSTALLATION OF RECESSED LOADING DOCK LEVELERS

A. Attach dock levelers securely to loading dock platform, flush with adjacent loading dock surfaces and square to recessed pit.

3.6 INSTALLATION OF STATIONARY LOADING DOCK LIFTS

A. Attach dock lifts securely to **[loading platform] [floor of recessed pit] [surface of driveway]**.

3.7 ADJUSTING

A. Adjust loading dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.

B. Test dock levelers for vertical travel and adjust to maintain operating range indicated.

C. After completing installation of exposed, factory-finished loading dock equipment, inspect exposed finishes and repair damaged finishes.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Project Director/COR's maintenance personnel to adjust, operate, and maintain loading dock equipment.

END OF SECTION 111305

SECTION 112173 - COMMERCIAL LAUNDRY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the types of commercial laundry equipment identified below.

1. Washing machine.
2. Dryer.

B. Related Sections:

1. Section 113013 “Residential Appliances” for residential grade appliances.
2. Division 22 Sections for piping and other associated plumbing work.
3. Division 26 Sections for connections, receptacles, and other associated electrical work.

1.2 SUBMITTALS

A. Product Data: For each equipment type required indicating compliance with requirements.

1. Include installation details, material descriptions, dimensions of individual components, and finishes for each equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Equipment Schedule: Submit schedule of equipment, using the same OBO Component Code and room designations shown on Drawings. Provide separate schedules for each building.

C. List of Equipment Service Agencies: Submit in writing a list of all manufacturers' representatives of the foodservice equipment, such as convection ovens, ranges, and their authorized service agencies' addresses and telephone numbers.

D. Operation and Maintenance Data: Operation, maintenance, and parts data for commercial-grade equipment to include in the maintenance manuals.

1. For each commercial-grade equipment item, include item number and description indicated in Contract Documents, manufacturer's name and model number, and authorized service agencies' addresses and telephone numbers. Provide divider for each commercial-grade equipment item. Organize manual name of the manufacturer. Provide cross-referenced index in the front of manual by (col.1) component code as shown on the plans, (col.2) component name, and (col.3) manufacturer and description. Include a removable reduced legible copy of the equipment plan with the item numbers.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage experienced installer to perform work of this Section who has specialized in installing commercial-grade equipment, who has completed installations similar in design and extent to that indicated for this Project, and who has record of successful in-service performance.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing commercial-grade equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. Product Options: Drawings indicate equipment size, profile, and dimensional requirements of equipment and are based on the salient characteristics indicated.

D. Electrical Appliances: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

E. ANSI Standards: Comply with applicable ANSI standards for electric-powered and gas-burning equipment; for piping to compressed-gas cylinders; and for plumbing fittings, including vacuum breakers and air gaps, to prevent siphonage in water piping.

F. Regulatory Requirements: Comply with the following National Fire Protection Association (NFPA) codes and standards:

1. The OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).
2. NFPA 54, "National Fuel Gas Code."

G. AGA Certification: Provide gas-burning appliances certified by the American Gas Association (AGA).

H. Energy Ratings: Provide Energy Star or equivalent as required in this Section.

I. [Accessibility: Refer to accessibility requirements in Chapter 11 of the OBO Building Code (relative to the Architectural Barriers Act (ABA) "Accessibility Guidelines for Buildings and Facilities") regarding required features and installation of appliances.]

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver commercial-grade equipment as factory-assembled units with protective crating and covering.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary plastic protective covering before shipment. Store commercial-grade equipment in original protective crating and covering and in a dry location. Covering shall be easily removable, and shall be removed after equipment installation is complete, or when otherwise directed by Project Director/COR.

PART 2 - PRODUCTS

2.1 GENERAL

A. In cases where an item can be furnished with different fuel sources, Contractor shall determine which are readily available regionally at project site to facilitate operation, maintenance, and replacement.

B. Refer to Part 3 Article on COMMERCIAL LAUNDRY EQUIPMENT SCHEDULE for salient characteristics on equipment.

2.2 FINISHES

A. For clothes washer and dryer, provide factory-applied porcelain-enamel white.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of commercial equipment.

B. Examine roughing-in for plumbing, mechanical, and electrical services, with Installer present, to verify actual locations of services before commercial equipment installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate equipment work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work. Furnish installation instructions to installers of related work as necessary for coordination of the installation. Place such items, including pipes, conduit, inserts and anchors, accurately in relation to the final location of equipment components.

B. Install all components of the equipment in accordance with the manufacturer's written instructions and recommendations.

C. Install equipment with access and maintenance clearances according to manufacturer's written instructions and requirements of local Authority Having Jurisdiction.

D. Verify plumbing, ventilation and electrical connection requirements for all equipment with manufacturer and coordinate connections with Division 22, 23 and 26.

E. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

3.4 ADJUSTING AND CLEANING

A. Test each item of commercial equipment to verify proper operation. Make necessary adjustments.

B. Verify that accessories required have been furnished and installed.

C. Remove temporary protective coverings and packing material from commercial equipment and leave units in clean condition, ready for operation.

3.5 COMMERCIAL LAUNDRY EQUIPMENT SCHEDULE

A. General:

1. This Article may list descriptions for commercial equipment items that are not included for the project. Refer to the equipment schedule in the Drawings to identify applicable equipment items.

B. The following commercial equipment shall be provided by the Contractor in accordance with the Schedule on the Drawings.

WASHING MACHINE, COMMERCIAL

(OBO Component Code PL029)

- Commercial homestyle grade, non-vending
- Freestanding, front-loading with signal
- Stainless steel tub
- Energy Star
- 6 cycles minimum
- Features shall include multiple load size, water temperatures, and wash cycles including pre-wash or second rinse cycle

- Time-remaining display
- Capacity: 9.5 kg (21.5 lb)
- Cylinder Volume: 96.8 liters (3.42 cu. ft.)

DRYER, COMMERCIAL

(OBO Component Code PL030)

- Commercial homestyle grade, non-vending, **[Electric] [Natural Gas]**
- Freestanding, front-loading with front controls
- Energy Star
- 6 cycles minimum
- Features shall include multiple temperature settings, and timed-drying
- Capacity: 8.2 kg (18 lb)
- Cylinder Volume: 198 liters (7 cu. ft.)

END OF SECTION 112713

SECTION 113013 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the types of residential appliances identified below.

1. Range hoods.
2. Refrigerator/freezers.
3. Dishwashers.
4. Clothes washers and dryers.
5. Microwaves.

B. Related Sections:

1. Division 06 Section on “Interior Architectural Woodwork” for cabinets and other architectural woodwork.
2. Division 11 Sections for commercial-grade equipment.
3. Division 22 Section on “Residential Plumbing Fixtures,” including garbage disposers.
4. Division 26 Sections for associated electrical work.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 SUBMITTALS

A. Product Data: For each appliance type required indicating compliance with requirements.

1. Include complete operating and maintenance instructions for each appliance.
2. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
3. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Appliance Schedule: Submit schedule of appliances, using the same OBO Component Code and room designations shown on Drawings. Provide separate schedules for each building; appliances for townhouse-type staff housing may be included in a single schedule.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is familiar with installation and maintenance of appliances required for this Project.

B. Product Options: Drawings indicate appliance size, profile, and dimensional requirements of residential appliances and are based on the salient characteristics indicated.

C. Electrical Appliances: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

D. **[High-Altitude [and] [Propane] Conversion: Where site is located above 600 m (2000 feet)[or where appliances use propane], provide gas-operated appliances with manufacturer's conversion kit installed by qualified service agency according to manufacturer's written instructions for Project location and type of fue**l.]

E. **[ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.]**

F. UL and NEMA Compliance: Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.

G. AHAM Standards: Provide appliances that comply with the following AHAM standards:

1. Refrigerators and Freezers: Total volume and shelf area ratings certified according to ANSI/AHAM HRF-1.

H. Energy Ratings: Provide Energy Star or equivalent as required in this Section.

I. [Accessibility: Refer to accessibility requirements in Chapter 11 of the OBO Building Code (relative to the Architectural Barriers Act (ABA) "Accessibility Guidelines for Buildings and Facilities") regarding required features and installation of appliances.

1. [SDA: Those SDA dwelling units identified as accessible dwelling units shall comply with OBO Building Code accessibility requirements.]
2. [Representational Residences: Appliances in Family Zone shall comply with OBO Building Code accessibility requirements.]]

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Deliver appliances only after utility rough-in is complete and construction in the spaces to receive appliances is substantially complete and ready for installation.

1.6 **[WARRANTY**

A. Professional-Grade Appliances: For appliances identified as professional-grade in this section, provide limited warranty including parts and labor for first year and parts thereafter.

1. **Warranty Period: [Five] years from date of Substantial Completion.]**

PART 2 - PRODUCTS

2.1 RESIDENTIAL APPLIANCES

A. Range (OBO Component Code SQ124):

1. Freestanding **[electric] [natural gas]** range with four-burners and single oven with broiler, listed by UL.

B. Range Exhaust Hood (OBO Component Code SQ125):

1. Wall-mounted, undercabinet unit exhaust hood, listed by UL.
2. Connect to exterior with rigid metal duct in accordance with OBO Mechanical Code Section 505. Exhaust in accordance with OBO Mechanical Code Section 508.3.2, including requirement for 189L/s (400 cfm) max.
3. Quiet operation.

C. Microwave Oven, Countertop (OBO Component Code SQ076):

1. Listed by UL, 56 L (2 cf) capacity.

D. Microwave Oven, Undercabinet (OBO Component Code SQ126):

1. Listed by UL, 28 L (1 cf) capacity minimum.
2. Connect to exterior with rigid metal duct in accordance with OBO-ICS IMC Section 505. Exhaust in accordance with OBO-ICS IMC Section 508.3.2, including requirement for 200 L/s (450 cfm) min. exhaust.

E. Dishwasher (OBO Component Code PL032):

1. Undercounter, automatic dishwasher, sized to replace 610-mm (24-inch) base cabinet, listed by UL, Energy Star.

F. Mini Refrigerator (OBO Component Code SQ127)**:**

1. Freestanding, undercounter two-door refrigerator with top mounted freezer, listed by UL, 85 L (3 cf) capacity min., frost-free, Energy Star.

G. Full Size Refrigerator (OBO Component Code SQ058):

1. Freestanding, two-door refrigerator with top-mounted freezer, listed by UL, 550 L (20 cf) capacity min., frost-free, Energy Star. No through-door ice/water dispenser.

H. Full Size Freezer (OBO Component Code SQ142):

1. Freestanding, freezer, listed by UL, 550 L (20 cf) capacity min., Energy Star.

2.2 PROFESSIONAL-GRADE RESIDENTIAL APPLIANCES

A. Professional-Grade Range (OBO Component SQ280):

1. Slide-in **[natural gas] [dual fuel] [electric]** range.

   a. Professional grade, dual fuel range.
   b. Minimum six-burners and griddle plate.
   c. Minimum 15,000 BTU Sealed Burners
   d. Easy clean units, with at least one a convection oven. Minimum three rack positions for rack in each oven.
   e. Minimum 115 L (4.1 cu. ft.) oven cavity at convection oven
   f. Minimum 30,000 BTU oven burner / 18,000 BTU broil burner
   g. Halogen oven lights.
   h. Listed by UL or CE.
   i. Stainless steel construction.
   j. Stainless steel backguard.

B. Professional-Grade Range Exhaust Hood (OBO Component SQ281):

1. Wall-mounted exhaust hood(s); for range(s).

   a. Professional grade, multi-speed wall hood.
   b. Coordinate width with professional grade range unit.
   c. Suitable for 15.2 m (50 feet) of duct run.
   d. Listed by UL or CE.
   e. Stainless steel construction.
   f. Minimum 565 L/s (1,200 cfm) blower motor
   g. Stainless steel washable baffle type filter system and removable trough for removing liquefied grease.
   h. 250-watt heat lamp.
   i. LED lighting with dimmer control.
   j. Fan on-off switch with heat sensor for automatic fan start.
   k. Connect to exterior with rigid metal duct in accordance with OBO Mechanical Code Section 505.
   l. Quiet operation.
   m. Interconnect with make-up air ventilation in accordance with model International Mechanical Code Section 505.

2.3 LAUNDRY APPLIANCES

A. Clothes Washing Machine (OBO Component Code PL027):

1. Freestanding, front-loading, automatic clothes washer, listed by UL, Energy Star. Features shall include multiple load size, water temperature, and wash cycles.

B. Clothes Dryer (OBO Component Code PL028):

1. Freestanding, front-loading, **[electric] [gas]** clothes dryer, listed by UL, Energy Star. Features shall include multiple temperature settings and timed-drying.

2.4 FINISHES

A. Provide manufacturer's standard smooth stainless-steel finishes for all appliances unless otherwise approved by the Project Director/COR, based on input from the A/E of Record, prior to submission. For clothes washer and dryer, provide factory-applied porcelain-enamel white.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.

B. Examine roughing-in for plumbing, mechanical, and electrical services, with Installer present, to verify actual locations of services before residential appliance installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate equipment work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work. Furnish installation templates, diagrams, and other data to fabricators and installers of related work as necessary for coordination of the installation. Place such items, including pipes, conduit, inserts and anchors, accurately in relation to the final location of equipment components.

B. Install all components of the equipment in accordance with the manufacturer's written instructions and recommendations.

C. Verify plumbing, ventilation and electrical connection requirements for all equipment with manufacturer and coordinate connections with Division 22, 23, and 26.

D. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

E. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

F. Clothes Dryer: Connect to exterior with sealed and insulated rigid metal duct with lint cleanout access.

G. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.

3.3 ADJUSTING AND CLEANING

A. Test each item of residential appliances to verify proper operation. Make necessary adjustments.

B. Verify that accessories required have been furnished and installed.

C. Remove temporary protective coverings and packing material from residential appliances and leave units in clean condition, ready for operation.

END OF SECTION 113013

SECTION 114000 – FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Food Service equipment as indicated on the Drawings.

B. Project-Specific Design System Selection:

1. [Gas] [Electric]
2. [Air-Cooled] [Water-Cooled]

C. OFOI Equipment Types: Please refer to the SRP-Ms for coordination of food service equipment which will be furnished and installed by others in accordance with the SRP-M Schedules on the Project Documents.

D. Related Sections include the following:

1. Division 03 Section on “Cast-in-Place Concrete” for equipment bases, curbs, and recesses as indicated.
2. Division 05 Section on “Metal Fabrications” for equipment supports.
3. Division 06 Section on “Interior Architectural Woodwork” for millwork, wood casework, and plastic-laminate substrates.
4. Rough-in work will be done as work of other Sections.
5. Refer to Division 21 Sections for connections to space fire-extinguishing systems.
6. Refer to Division 23 Sections for supply and exhaust fans; exhaust ductwork upstream from exhaust hood or vent collar; connection of exhaust ductwork to exhaust hood or vent; make-up and ventilation system; HVAC controls, control wiring, switches, and interlocking devices; service roughing-ins; floor drains and traps; atmospheric vents; valves, pipes, and fittings; and other materials required to complete food service equipment installation.
7. Refer to Division 26 Sections for connections to wiring between starters, disconnects, wall receptacles, and other electrical materials required to complete food service equipment installation.
8. Division 28 Section on “Addressable Fire Alarm Systems” for connections to building fire alarm system required to complete food service equipment installation.

1.2 SUBMITTALS

A. Product Data: For each type of food service equipment indicated. Include manufacturer's model number and accessories and requirements for access and maintenance clearances, water and

drainage, power or fuel, and service-connections including roughing-in dimensions. Provide voltage, frequency and amperage for equipment without published export voltage documentation.

B. Shop Drawings: For food service equipment not manufactured as standard production and catalog items by manufacturers. Include plans, elevations, and sections at minimum 1:20 scale, roughing-in dimensions, fabrication details, service requirements, and attachments to other work.

1. Fabricated Equipment: Fully detailed and dimensioned at minimum scale of 1:20 for plan and elevation views, and 1:10 for sections.
2. Drawings showing location and size of all bases, depressions, special height walls, location of equipment requiring structural support in walls, openings in walls for equipment at minimum scale of 1:50.
3. Wiring Diagrams: Details of wiring for power, signal, and control systems for electrically operated systems. Differentiate between manufacturer-installed and field-installed wiring.
4. Piping Diagrams: Details of piping systems and differentiating between manufacturer-installed and field-installed piping.

C. Wet-Chemical Fire Suppression System: Prepare shop drawings according to NFPA 17A. Submit working plans and product data for fire suppression system to OBO OPS/FIRE/FPE for review and approval. Submittal shall include all necessary information for a complete and thorough review of proposed wet-chemical fire suppression system.

D. Coordination Drawings: For locations of food service equipment and service utilities. Key equipment with item numbers and descriptions indicated in Contract Documents. Include plans and elevations of equipment, access- and maintenance-clearance requirements, details of built-in equipment bases and floor depressions, and service-utility characteristics.

E. Equipment Schedule: For each food service equipment item, include item designator and description indicated on Contract Documents, manufacturer’s name and model number. For equipment items requiring operational servicing (e.g., convection ovens, refrigeration units), identify information for authorized service agencies; company name, agency address, and contact information.

F. Samples for Initial Selection:

1. Manufacturer's color charts showing the full range of colors available for exposed products with color finishes.
2. Plastic nameplate, including information on available colors and text style.

G. Samples for Verification: Of each type of exposed finish required, minimum 100-mm square or 150-mm long sections of linear shapes and of same thickness and material indicated for work. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.

H. Product Certificates: Signed by manufacturers of refrigeration systems or their authorized agents certifying that systems furnished comply with requirements and will maintain operating temperatures indicated in the areas or equipment that they will serve.

1. Certify that each refrigeration system is properly sized and meets operating requirements set forth for each system regarding maintaining specified operating temperature, hours of compressor running time, and system pressures and velocities as recommended by equipment manufacturer.

I. List of Equipment Service Agencies: Submit in writing a list of all manufacturers' representatives of the foodservice equipment, such as convection ovens, ranges, and their authorized service agencies' addresses and telephone numbers.

J. Maintenance Data: Operation, maintenance, and parts data for food service equipment to include in the maintenance manuals.

1. For each food service equipment item, include item number and description indicated in Contract Documents, manufacturer's name and model number, and authorized service agencies' addresses and telephone numbers. Provide divider for each food service equipment item. Organize manual name of the manufacturer. Provide cross-referenced index in the front of manual by (col.1) component code as shown on the plans, (col.2) component name, and (col.3) manufacturer and description. Include a removable reduced legible copy of the equipment plan with the item numbers.

K. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing food service equipment, who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in-service performance. Designers and installers of wet-chemical fire suppression systems shall be manufacturer certified.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing food service equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. Product Options: Drawings indicate food service equipment based on the specific products indicated. Other manufacturers' equipment with equal size and performance characteristics may be considered.

D. Regulatory Requirements: Comply with the following National Fire Protection Association (NFPA) codes and standards:

1. The OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).
2. NFPA 17A, "Standard for Wet Chemical Extinguishing Systems."
3. NFPA 54, "National Fuel Gas Code."
4. NFPA 96, " Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."

E. Listing and Labeling: Provide electrically operated equipment or components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the NFPA 70, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

F. AGA Certification: Provide gas-burning appliances certified by the American Gas Association (AGA).

G. ASME Compliance: Fabricate and label steam-generating and closed steam-heating equipment to comply with ASME Boiler and Pressure Vessel Code.

H. ASHRAE Compliance: Provide mechanical refrigeration systems complying with the American Society of Heating, Refrigerating and Air-Conditioning Engineers' ASHRAE 15, "Safety Code for Mechanical Refrigeration."

I. NSF Standards: Comply with applicable NSF International (NSF) standards and criteria and provide NSF Certification Mark on each equipment item, unless otherwise indicated.

J. ANSI Standards: Comply with applicable ANSI standards for electric-powered and gas-burning appliances; for piping to compressed-gas cylinders; and for plumbing fittings, including vacuum breakers and air gaps, to prevent siphonage in water piping.

K. SMACNA Standard: Where applicable, fabricate food service equipment to comply with the Sheet Metal and Air Conditioning Contractors National Association's (SMACNA) "Kitchen Equipment Fabrication Guidelines," by the Sheet Metal and Air Conditioning Contractors National Association's (SMACNA), unless otherwise indicated.

1. Seismic Restraints: Provide OBO Building Code provisions require seismic restraints for food service equipment, provide restraints in accordance with SMACNA’s "Kitchen Equipment Fabrication Guidelines" unless otherwise indicated.

L. Preinstallation Conference: Conduct conference at Project site to comply with requirements to review methods and procedures related to food service equipment including, but not limited to, the following:

1. Review access requirements for equipment delivery.
2. Review equipment storage and security requirements.
3. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
4. Review structural loading limitations.
5. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.4 LABELING

A. Nameplates: Provide nameplates to identify controls and switches on fabricated equipment. Nameplates shall be two-ply 25 mm, rigid plastic material specifically manufactured for this purpose. Machine engrave nameplate with white letters on black background, with edges beveled at a 45 deg. angle. Attach nameplates using an adhesive recommended by manufacturer of engraving material.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver food service equipment as factory-assembled units with protective crating and covering.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary plastic protective covering before shipment. Coating shall be easily removable, and shall be removed after equipment installation is complete, or when otherwise directed by Project Director/COR.

C. Schedule delivery of equipment to prevent delays in Project, including delays in associated work.

D. Store food service equipment in original protective crating and covering and in a dry location.

E. Do not use walk-ins for construction storage.

F. Government-Furnished Government-Installed Equipment: As identified by the Government, the Government will furnish and install specific food service equipment items. Contractor shall coordinate space, cutouts, and utilities as applicable, and as defined by the Government.

G. **[Reused Equipment: As identified by the Government, coordinate and show sizes, utilities, and other requirements as determined by inspecting equipment as existing to be reused. Include costs for tagging, marking, removing, storing, cleaning, redelivering, and installing such equipment. Provide accessories identified as necessary for equipment to conform to new application.]**

1.6 PROJECT CONDITIONS

A. Do not begin installation of equipment until building is sufficiently clean, and until the operating temperatures and humidity in the spaces to receive the equipment conform to requirements of food service manufacturers.

1.7 COORDINATION

A. Coordinate size, location, and requirements of concrete bases, positive slopes to drains, floor depressions, and insulated floors. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section on "Cast-in-Place Concrete."

B. Coordinate timing of equipment access. If necessary, coordinate with Contractor regarding timing of construction of secondary walls, non-security doors, and similar construction to facilitate moving food service equipment to their proper location.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section on roof accessories.

D. Coordinate installation of food service equipment with installation of flooring and wall tile.

E. Coordinate equipment layout and installation with other work, including light fixtures, HVAC equipment, and fire-suppression system components.

F. Coordinate connection location and requirements of service-utility connection installation with project fire protection, mechanical, and electrical subcontractors.

1.8 WARRANTY

A. General Warranty Provisions: The special warranty specified in this Article shall not deprive the Government of other rights the Government may have under other warranty provisions of the Contract, and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract.

B. Refrigeration Compressor Warranty: Submit a written warranty signed by manufacturer agreeing to repair or replace compressors that fail in materials or workmanship within the specified warranty period.

1. Failures include, but are not limited to, the following:

a. Breakage
b. Faulty operation, including inability to maintain set temperature.

2. Warranty Period: 5 years from date of Substantial Completion.

C. Wet-Chemical Fire Suppression System Warranty: The pre-engineered suppression system shall be warranted for five years from the date of delivery against defects in workmanship and material.

1.9 EXTRA MATERIALS

A. Extra materials shall match products installed. Package these materials with protective covering for storage, and include labels describing content. Provide the following:

1. Commercial Kitchen Hood: One (1) device for grease removal.

1.10 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date for a period of one calendar year with a renewable option for an additional year, provide proposal for system maintenance service based on manufacturer's recommended daily, weekly, quarterly, semi-annual, and annual maintenance activities. The proposal shall be submitted to the COR/Project Director at least 120 days prior to Substantial Completion.

B. The proposal shall be inclusive of controls set-up and programming, troubleshooting, and alarms based on manufacturer's recommendations and the operation and maintenance information, using factory-trained service personnel.

C. Maintenance service shall include preventive maintenance, repair or replacement of worn or defective components, required supply of cleaning solutions and specialty tools, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks shall also align with the manufacturer's recommended checklists as required in Division 01 Section 017825 "Systems Manual and O&M Data." Provide completed maintenance records inclusive of scheduling to the USG for inclusion in the CMMS.

PART 2 - PRODUCTS

2.1 GENERAL

A. In cases where an item can be furnished with different fuel sources or, in the case of refrigeration, various cooling methods, Contractor shall determine which are readily available regionally at project site to facilitate operation, maintenance, and replacement.

2.2 MATERIALS

A. Stainless-Steel Sheet, Strip, Plate, and Flat Bar: ASTM A 240, A 666, Type 304 Condition A, 18-8, stretcher leveled, No. 4 finish. At surfaces which are not exposed to view, No. 2B finish may be used. No lighter than 0.095 mm in thickness should be incorporated into the work.

B. Stainless-Steel Tube: ASTM A 554, Grade MT-304.

C. Stainless Steel Rolled Shapes: Cold-rolled type conforming to ASTM A 36.

D. Zinc-Coated Steel Sheet: ASTM A 653, G-115 coating designation. Commercial quality, cold rolled, stretcher leveled, and chemically treated.

E. Zinc-Coated Steel Shapes: ASTM A 36M, zinc-coated in accordance with ASTM A 123.

F. Plastic Laminate: Complying with NEMA LD 3 and NSF 35 requirements. NSF certified for end-use application indicated; 1.27 mm thick for horizontal and vertical surfaces, and 1.07 mm thick for post-formed surfaces; smooth texture; and easily cleanable.

1. Color: As indicated, or otherwise as selected by Project Director/COR based upon input from OBO/PDCS/DE from manufacturer's full range of colors.

G. Plywood and Lumber: Provide plywood and lumber as specified in Division 06 Section on "Interior Architectural Woodwork."

H. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Provide elastomeric sealant NSF certified for end-use application indicated. Provide sealant that, when cured and washed, complies with U.S. Food and Drug Administration (FDA) 21 CFR, Section 177.2600 for use in areas that come in contact with food. Provide at backsplashes to walls, cabinet bodies to concrete or tile bases, roll-in refrigerators to floor, and similar applications. Match surrounding surfaces and applied in accordance with manufacturer's recommendations for smooth, sealed finish.

1. Color: As indicated, or otherwise as selected by Project Director/COR based upon input from OBO/PDCS/DE from manufacturer's full range of colors.
2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

I. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), Class 1 (clear), Quality q3 (glazing select). Provide products complying with ANSI Z97.1, manufactured by horizontal (roller-hearth) process, and 6 mm thick, unless otherwise thicker glazing indicated. Provide exposed safety edges, if any, seamed before tempering.

J. Plastic: Except for plastic laminate, provide plastic materials and components complying with NSF 51.

K. Sound Dampening: NSF-certified, 3-mm thick, tape type, sound-deadening material coating.

L. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds.

2.3 ACCESSORIES

A. Cabinet Hardware: Provide NSF-certified, stainless-steel hardware for equipment items as indicated.

2.4 FABRICATION, GENERAL

A. All fabricated equipment shall be fabricated in same factory, and shall be similar in construction details, materials, methods, and appearance to similar types of items fabricated under this contract.

B. Fabricate food service equipment in accordance with NSF 2. Factory assemble equipment to greatest extent possible.

C. Design of equipment shall be such as to provide for safe and convenient operation. Provide covers or other safety devices presenting safety hazards; such guards or safety devices shall not substantially interfere with operation of equipment. All guards shall provide easy access to guarded parts.

D. Each fabricated item of equipment shall include all necessary reinforcing, bracing, and welding with sufficient number and spacing of uprights and cross members for strength. Wherever standard sheet sizes permit, tops of tables, shelves, exterior panels of cabinet type fixtures, doors, and drain boards shall be constructed of single sheet of metal. Except where required to be removable, secure flat surfaces to vertical and horizontal bracing members by welding or other approved means to eliminate all buckle, warp, rattle, and wobble. Equipment which is not braced in a rigid manner, and which is subject to rattle and wobble is unacceptable; provide additional bracing in manner acceptable to Project Director/COR.

E. Plastic-Laminate and Wood Casework: Fabricate according to requirements specified in Division 06 Section on “Interior Architectural Woodwork.”

F. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion, and which develop strength and corrosion resistance of base metal. Provide welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Provide full-penetration welds for full-joint strength. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
2. Grind exposed welded joints flush with adjoining material, and polish to match adjoining surfaces.
3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and underpressed.
4. Coat unexposed stainless-steel welded joints with suitable metallic-based paint to prevent corrosion.
5. After zinc-coated steel is welded, clean welds and abraded area, and apply SSPC-Paint20, high-zinc dust content galvanizing repair paint conforming with ASTM A 780.

G. Fixtures shall be shop fabricated of one piece and shipped to job completely assembled wherever possible. Equipment too large to transport or enter the building as one piece shall be constructed so that the field joints can be welded at the job site.

H. Fabricate field-assembled equipment prepared for field-joining methods indicated. For metal butt joints, conform to SMACNA "Kitchen Equipment Fabrication Guidelines,", unless otherwise indicated.

I. Where stainless steel is joined to dissimilar metal, use stainless-steel welding material or fastening device.

J. Form metal with break bends that are not flaky, scaly, or cracked in appearance. Where breaks mar uniform surface appearance of material, remove such marks by suitable grinding, polishing, and finishing.

K. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

L. Provide surfaces in food zone, as defined in NSF 2, free from exposed fasteners.

M. Exposed surfaces shall be free from bolt and screw heads. When bolts are required, they shall be of concealed type and be of similar composition as metal to which they are applied. Where bolt or screw threads on interior of fixtures are visible or may come into contact with hands or wiping cloths. Cap exposed fastener threads, including those inside cabinets, with stainless steel cap (acorn) nut and stainless steel lock washers.

N. Provide pipe slots on equipment with turned-up edges. and size to accommodate service and utility lines and mechanical connections.

O. Provide enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices, including those inside cabinets, unless otherwise indicated.

P. Seismic Restraints: Fabricate as applicable to comply with SMACNA as referenced in the Article on QUALITY ASSURANCE, unless otherwise indicated.

Q. Appliances shall be of rigid construction, free from objectionable vibration. Food service equipment shall operate quietly. Installed equipment producing objectionable noise or vibration shall be replaced as directed by Project Director/COR.

2.5 STAINLESS-STEEL EQUIPMENT

A. Edges and Backsplashes: Provide equipment edges and backsplashes indicated conforming to SMACNA "Kitchen Equipment Fabrication Guidelines," unless otherwise indicated.

B. Sound Dampening: Place between metal support structures and underside of metal work surfaces.

C. Tables: Fabricate with reinforced tops, legs, and reinforced undershelves or cross bracing to conform to SMACNA "Kitchen Equipment Fabrication Guidelines," unless otherwise indicated, and as follows:

1. Tops: Minimum 1.98-mm (0.0781-inch) (14-gauge) thick stainless steel, unless otherwise indicated.
2. Legs: 40-mm (1-5/8-inch) OD, minimum 1.59-mm (0.0625-inch) (16-gauge) thick stainless steel with stainless-steel gusset and adjustable insert bullet-type feet with minimum adjustment of 25 mm (1-inch) up or down without exposing threads, unless otherwise indicated.
3. Undershelves: Minimum 1.98-mm (0.0781-inch) thick stainless steel, unless otherwise indicated.
4. Top and Undershelf Reinforcement: Minimum 1.98-mm (0.078-inch) thick, stainless-steel reinforcing, unless otherwise indicated.
5. Cross Bracing: 32 mm 1-1/4-inch OD, minimum 1.59-mm (0.0625-inch) thick stainless steel, unless otherwise indicated.

D. Sinks: Fabricate of minimum 1.98-mm (0.078-inch) thick stainless steel with fully welded, one-piece construction. Construct two sides and bottom of sink compartment from one stainless-steel sheet, with ends welded integral and without overlapping joints or open spaces between compartments. Provide double-wall partitions between compartments with 13-mm (1/2-inch) radius rounded tops that are welded integral with sink body. Cove horizontal, vertical, and interior corners with 19-mm (3/4-inch) radius. Pitch and crease sinks to waste for drainage without pooling. Seat wastes in die-stamped depressions without solder, rivets, or welding.

1. Wastes: 50-mm (2-inch) nickel-plated bronze, rotary-handle waste assembly with stainless-steel strainer plate and nickel-plated brass, connected overflow.
2. Drainboards: Minimum 1.98-mm (0.078-inch) thick stainless steel, pitched to sink at 3mm/300 mm (1/8-inch/12 inches) of length. Reinforce drainboards with minimum 1.98-mm (0.078-inch) thick stainless steel 32-mm (1-1/4 inch) angle, unless otherwise indicated.
3. Legs: 40 mm (1-5/8-inch) OD, minimum 1.59-mm (0.0625-inch) thick stainless steel with stainless-steel gusset welded to 2.78-mm (0.11-inch) thick, stainless-steel support plate. Provide adjustable insert bullet-type feet with minimum adjustment of 25 mm (1-inch) up or down without exposing threads, unless otherwise indicated.
4. Drainboard Braces: 25-mm (1-inch) OD, minimum 1.59-mm (0.0625-inch) thick stainless steel, unless otherwise indicated.
5. Cross Bracing: 38 mm (1-1/2 inch) OD, minimum 1.59-mm (0.0625-inch) thick stainless steel, unless otherwise indicated.

E. Wall Shelves and Overshelves: Fabricate to conform to SMACNA "Kitchen Equipment Fabrication Guidelines," unless otherwise indicated, and with minimum 1.59-mm (0.0625-inch) thick, stainless-steel shelf tops.

F. Drawers: Provide lift-out type, one-piece, die-stamped drawer pan fabricated from 1.27-mm (0.05-inch) thick stainless steel with inside corners formed with proper radius. Support drawer pan with 1.59-mm (0.0625-inch) thick, stainless-steel channel frame welded to drawer front. Provide 25-mm (1-inch) thick, double-wall front fabricated from 1.59-mm (0.0625-inch) thick stainless steel and with integral recessed pull. Fill void in drawer front with semi-rigid fiberglass sound dampening. Mount drawers on NSF-certified, full-extension, stainless-steel drawer slides that have minimum 45-kg (100-lb) load capacity per pair, ball-bearing rollers, and positive stop. Mount drawer slides for self-closing on drawer housing as indicated.

2.6 STAINLESS STEEL FINISHES

A. General: Comply with NAAMM "Metal Finishes Manual for Architectural and Metal Products" for application and designation of finishes.

1. Remove or blend tool and die marks and stretch lines into finish.

B. Concealed Surfaces: No. 2B finish (bright, cold-rolled, unpolished finish).

C. Exposed Surfaces: No. 4 finish (bright, directional polish).

1. Grind and polish surfaces to produce uniform, directional textured, polished finish indicated, free of scratched. Run grain with long dimension of each piece.

2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter, and leave surfaces chemically clean.

2.7 EXHAUST HOOD FABRICATION

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aerolator Systems, Inc.
2. AHR Metals, Inc.; Air Saver Systems.
3. Air Tech; Delfield Company (The).
4. AyrKing Corporation.
5. Captive-Aire Systems.
6. Carroll Manufacturing International.
7. Duke Manufacturing Company.
8. Gaylord Industries, Inc.
9. Giles Enterprises, Inc.
10. Grease Master; a division of Custom Industries, Inc.
11. Greenheck.
12. Halton Company.
13. LCSystems, Inc.
14. Sturdi-Bilt Restaurant Equipment.
15. Vent Master; Div. of Garland Commercial Ranges, Ltd.

B. General: Type I exhaust hood. Comply with NSF 2 and NFPA 96.

1. Refer to Division 21 Sections for fire-extinguishing system requirements.
2. Refer to Division 23 Sections for duct, fan, and damper requirements.

C. Grease Removal: Provide removable, stainless-steel, baffle-type grease filters with spring-loaded fastening. Provide minimum 1.98-mm thick, stainless-steel filter frame and removable collection basins or troughs.

D. Light Fixtures: Provide NSF-certified fixtures with lamps, vapor-tight sealed lenses, and wiring in stainless-steel conduit on hood exterior.

E. Exhaust-Duct Collars: Minimum 1.59-mm thick stainless steel.

F. Below Hood Wall Cladding: Provide 18-gauge type 300 or equal quality polished stainless steel, with no pop riveting from finished floor to underside of exhaust hood. Wall cladding shall run the full width and depth of the exhaust hood dimensions.

2.8 ELECTRICAL FABRICATION

A. Provide commercial grade signals, "on-off" pushbuttons or switches, and other speed and temperature controls as required for operation of each item. Include the following:

1. Pilot lights.
2. Identification: Permanent engrave, or provide plastic laminate signs and graphics to identify each item.
3. Stainless steel cover plates at controls and signals.

B. Equip each item requiring electrical power with either terminal box for permanent connection, or with cord and plug for interruptible connection, as indicated. Grounding-type plugs shall be NEMA standard.

C. Fabricate foodservice equipment completely wired internally using wire and conduit suitable for wet locations, including separate grounding wire.

D. Provide electrical outlets and receptacles required to be mounted on or in fabricated equipment, and interconnect to suitable terminal box (subpanel, starter, or disconnect switch) with all wires neatly tagged showing item number, voltage characteristics, and load information.

E. Provide appropriate grounding-type connectors and neoprene cords installed on each item of plug-in equipment. Coordinate work with electrical work in project so that receptacles provided match specific plugs provided as part of plug-in equipment. Reduce length of cords furnished with specified equipment to suitable or appropriate length so they do not interfere with other equipment or operations.

F. Internally wire electrically-heated equipment to thermostatic control and to "on-off" red neon light indicator. Mount light indicator in terminal box on removable stainless steel access panel.

G. Use only rigid steel conduit where unexposed. Use chrome-plated conduit where exposed. Run wiring concealed wherever possible.

H. Provide on or for each motor-driven appliance or electrical heating or control unit a suitable control switch or starter of proper type and rating, and in accordance with Underwriters Code wherever such components are not built in. Other line switches, safety cut-outs, control panels, fuse boxes, other control fittings, and connections, when not integral part of unit or furnished

loose by equipment manufacturer, shall be furnished and installed by as part of the Division 26 electrical work. Electrical controls, switches, or devices furnished with food service equipment shall be delivered loose for field installation as part of Division 26 electrical work associated with each scheduled item of equipment.

I. Fabricated equipment shall be so wired, wound, or constructed to conform to the characteristics of electrical and other services at job site.

J. Fabricate appliances complete with motors, driving mechanism, starters, and controllers, including master switches, timers, cut-outs, reversing mechanism, and other electrical equipment.

K. Appliances shall be of rigid construction, free from objectionable vibration. Food service equipment shall operate quietly. Installed equipment producing objectionable noise or vibration shall be replaced as directed by Project Director/COR.

L. Motors:

1. Drip-proof, splash-proof, or totally enclosed type, having continuous duty cycle and ball bearings, except small timing motors may have sleeve bearings.
2. Windings shall be impregnated to resist moisture.
3. Motors, located where they are subject to deposits of dust, lint, or other similar matter from machine on which installed, shall be of totally enclosed type.
4. Motors shall have ample power to operate machines for which designated under full load operating conditions without exceeding their nameplate ratings.
5. Manufacturer, based on normal operation at maximum capacity, shall determine horsepower requirements on driven equipment.
6. Nominal rated motor horsepower shall be not less than horsepower required for normal operation of equipment at maximum capacity.
7. Insulation: NEMA Class B minimum.

M. Switches, controls, and similar electrical components shall be conspicuously labeled, with label secured to adjacent surface.

N. Where specified for custom fabricated equipment, provide compartment with electrical sub-panel that shall be pre-wired in conduit concealed in cabinet body construction and connected to electrical components built into or set upon the counter. Electrical sub-panel shall be as follows:

1. UL listed, 3-phase, 4-wire circuit breaker type with ground buss main breaker and individual breakers for each serviced load.
2. Buss shall be copper. Circuit breakers shall be molded case, bolt-on type with thermomagnetic quick-make, quick-break trip.
3. Multi-pole circuit breakers shall have internal trip bar.
4. Circuit breakers shall have interrupting capacity as indicated by short circuit and coordination study; while typical AICs for countries with 120 V, 60 Hz distribution is 10,000 amperes, the AIC may vary for countries with 220 V, 50 Hz distribution.
5. Provide separate breaker for each connected load.

6. Size each breaker for 125 percent of connected load. Provide single pole, 20 amp circuit breakers To accommodate each counter appliance and convenience receptacle.
7. Connect loads through breakers in phased sequence to balance load on each phase.

2.9 PLUMBING FABRICATION

A. Locate water inlets above positive water level wherever possible to prevent siphoning of liquids into water supply system.

1. Wherever conditions require submerged inlet, provide suitable type of check valve and vacuum breaker with fixture to prevent siphoning of liquids; adjust in locations where local Authorities Having Jurisdiction prohibit use of check valves.
2. Where exposed, piping and fittings shall be chrome-plated.
3. Where vacuum breaker piping is through equipment, provide chrome -plated escutcheon plates to cover holes.

B. Fabricate indirect waste lines from equipment to discharge into floor drains or safe wastes. Plates shall be chrome-plated where exposed. Extend line to point at least 25 mm (1 inch) above rim of floor drain, and higher if required by local Authority Having Jurisdiction; cut bottom on 45-degree angle, and secure in position.

C. Run horizontal piping lines at highest possible elevation, and at not less than 150 mm (6 inches) above floor, and through equipment where possible.

D. No exposed piping in or around fixtures or in other conspicuous places shall show tool marks or more than one thread at the fitting.

E. Provide suitable pressure-reducing valves for all equipment with such components that might be affected over time by adverse pressure conditions, including but not limited to dishwashers, booster heaters, coffee urns, and steam boilers.

2.10 REFRIGRATION SYSTEMS

A. Provide and install complete refrigeration systems, charged, started, and operating properly, including, but not limited to:

1. Compressors, condensers, racks, coils, vibration eliminators, sight glasses (moisture indicating type), expansion valves, filters, oil separators, thermostats, defrost time clocks, all controls and control wiring, liquid line driers, piping, and refrigeration grade copper tubing with all sweat joints using silver solder (with as few joints as possible)

B. Where specifications call for pre-piped lines (e.g., from fixture to valve compartment), provide such work in conformance with Board of Fire Underwriters or ASHRAE Standards, whichever is the greater.

C. Mechanically refrigerated cold pans shall have normally closed liquid line electric solenoid valve installed before expansion valve, and wired to silent- type toggle switch complete with "on-off" red neon light indicator, and both mounted in terminal box on removable access panel. This switch shall be fed by separate control circuit, and shall not to be wired into compressor circuit so that it shall stop the flow of refrigerant to cold pan and not turn off compressor. Compressor shall then pump down and turn off through action of pressure control.

D. Refrigeration equipment shall be designed and installed to maintain the following general temperatures unless otherwise specified:

1. Walk-in Refrigerator: 1.5 deg. C
2. Walk-in Freezer: -25 deg. C
3. Reach-in Refrigerators: 1.5 deg. C
4. Reach-in Freezers: -25 deg. C
5. Undercounter Refrigerators: 1.5 deg. C
6. Undercounter Freezers: -25 deg. C
7. Cold Pan: -20 deg. C
8. Work Rooms: 10 deg. C

E. Provide electrical and refrigeration components necessary for complete refrigeration systems.

F. Provide evaporator coil defrost system for walk-in refrigerator and freezer rooms where refrigeration systems is designed to operate at room temperature of less than 1.5 deg.C. Verify and provide additional refrigeration specialties and components required by manufacturer for proper operation under specific operating conditions and location of each system specified.

G. Install and wire refrigeration systems in conformance with manufacturer's instructions and recommendations. Ensure that condensing units are ventilated properly and are accessible for repair, maintenance, and inspection.

H. Furnish 2.66 mm (12 gauge) galvanized steel fish plates of suitable size and shape on exterior ceiling of the walk-in to spread weight of coils adequately.

I. Refrigeration tubing shall be the Type L, ACR hard drawn degreased, sealed copper.

J. Furnish minimum 12 mm armaflex or equal cellular type insulation for suction and refrigerant lines. Furnish metal pipe sleeves for building penetrations. Install permanent suction line filter in each compressor suction line with pressure fitting ahead of filter to facilitate checking of pressure drop through filter. Furnish escutcheon plate for sealing refrigeration and drain lines.

K. Provide thermostat to control refrigeration temperatures for each individual compartment.

L. Mount condensing units shall be mounted on welded steel rack. Rack shall contain all accessories and components necessary to form complete condensing unit package. Each condensing unit shall have factory mounted, prewired control panel/disconnect switch complete with circuit breakers, contactors, and time clocks. Fabricate systems with control and thermostat wiring installed.

M. Provide each walk-in refrigerator or freezer compartment with its own temperature indicator, located on exterior of walk-in complex. Minimum dial size shall 100 mm. Digital readouts shall be easily readable from 6 m away. Locate temperature sensing bulbs within inlet stream of blower coil, not on door panel, or other location.

N. Provide plexiglass framed holder for refrigeration system control wiring and piping diagrams. Mount at compressor location.

O. Provide thermometers for walk-in units with suitable length armored capillary tubes to allow sensing bulb to be installed in incoming air stream to blower coil with all runs fastened to walk-in walls to prevent it from damage. This identical requirement applies to alarm systems when specified.

2.11 WET-CHEMICAL FIRE SUPPRESSION SYSTEMS

A. Provide and install an automatic fire suppression system using a wet chemical agent for grease-related fires. Dual agent concept (wet chemical agent and water) is permitted. Wet chemical fire suppression system shall be designed and installed in accordance with the OBO Fire Code, NFPA 96, and NFPA 17A.

B. The system shall be capable of suppressing fires in the following areas associated with cooking equipment: ventilating equipment including hoods, ducts, plenums, and filters; fryers; griddles and range tops; upright, natural charcoal, or chain-type broilers; electric, lava rock, mesquite or gas-radiant char-broilers.

C. The system shall be the pre-engineered type having minimum and maximum guidelines established by the manufacturer and listed by Underwriters Laboratories, Inc. (UL).

D. The system shall be designed, installed, and serviced by personnel trained and certified by the manufacturer.

E. The system shall be designed to provide full hood continuous protection utilizing overlapping nozzle appliance protection that covers the complete appliance line under the total hood length. Cooking appliances with enclosed cooking hazards shall also be provided with nozzles dedicated to the appliance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of food service equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine roughing-in for piping, mechanical, and electrical systems to verify actual locations of connections before installation.

C. Equipment Access: Check all door openings, passageways, elevators, and any other site restrictions which may affect delivery and placement of equipment their proper location in the building.

D. Field Dimensions:

1. Verify field dimension at site of food service equipment installation areas by field measurement before equipment fabrication, and indicate measurements on Shop Drawings and Coordination Drawings. Coordination fabrication schedule with construction progress to avoid delay of the Work.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish required dimensions, and proceed with fabricating equipment without field measurements. Coordinate construction to ensure actual dimensions correspond to established dimensions.

3.2 INSTALLATION, GENERAL

A. Install food service equipment level and plumb, according to manufacturer's written instructions, original design, and referenced standards.

B. Complete equipment field assembly, where required, using methods indicated.

1. Provide closed butt and contact joints that do not require a filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Article on FABRICATION, GENERAL.

C. Install equipment with access and maintenance clearances according to manufacturer's written instructions and requirements of local Authority Having Jurisdiction.

D. Provide cutouts in equipment, neatly formed, where required to run service lines through equipment to make final connections.

E. Except for mobile and adjustable-leg equipment, securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

F. Install cabinets and similar equipment on concrete or masonry bases in a bed of sealant.

G. Install hoods to comply with NFPA 96 requirements and to remain free from vibration when operating.

H. Install seismic restraints according to SMACNA "Kitchen Equipment Fabrication Guidelines."

I. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 1200 mm (48 inches) o.c. maximum.

J. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

1. Install sealant at backsplashes to walls, cabinet bodies to concrete or tile bases, roll-in refrigerators to floor, and similar applications. Match surrounding surfaces, and apply in accordance with manufacturer's recommendations for smooth, sealed finish.

K. Seal equipment which butts to wall or against other equipment with silicone rubber sealant. Set trim strips or other items requiring fasteners in bed of silicone rubber sealant, and fasten with suitable stainless steel fasteners 1200mm or less on centers. Prior to application of sealant, thoroughly clean and degrease surfaces.

L. Install equipment, such as pass-through refrigerators and warmers, which pass through wall where one side is exposed to public view with operating controls located on kitchen or working side of wall. Install equipment, such as coffee urn, which is located on or in counter having pick-up side and working side, with operating controls facing working side of counter.

3.3 ELECTRICAL INSTALLATION

A. Line switches, safety cut-outs, control panels, fuse boxes, other control fittings, and connections associated with food service equipment, when not integral part of unit or furnished loose by equipment manufacturer, shall be furnished and installed by as part of the Division 26 electrical work.

1. Electrical controls, switches, and similar electrical devices are fabricated with food service equipment and delivered loose for field installation as a part of each scheduled item shall be installed as part of Division 26 electrical work.
2. Final electrical connections of food service to electrical panel shall be made by electrician as part of Division 26 electrical work after food service equipment is installed.

3.4 PLUMBING INSTALLATION

A. Install indirect waste lines from equipment which shall discharge into floor drains or safe wastes; install chrome-plated lines in portions that are exposed. Extend to point at least 25 mm above rim of floor drain, cut bottom on 45-degree angle, and secure in position.

B. Run horizontal piping lines at highest possible elevation, and not less than 150 mm above floor, through equipment where possible.

3.5 REFRIGERATION SYSTEMS INSTALLATION

A. Complete connections between electrical and refrigeration components with respective refrigeration systems.

B. Hang the evaporator coils per manufacturer's recommendation at locations as shown on Drawings. Units shall be mounted sloping such that drain pans are pitched to drain lines. Coils shall be hung using nylon or other approved non-conductive, non-corrosive fasteners. Unless specified otherwise, coils shall be installed 100mm from interior walk-in ceiling. Connect coils to condensing units to provide complete working system capable of maintaining interior temperatures specified regardless of heavy usage walk-in units may receive.

C. Provide copper or PVC drain line from each coil outlet to point 25mm above floor drain. Drain lines shall be trapped immediately above floor drain. Wrap freezer drain line with continuous electrified heater tape that shall be furnished as part of refrigeration system contract. Install drain lines in such a way that they do not interfere with placement of shelving inside walk-in. To extent possible, route drain lines outside walk-in refrigerator complex.

D. Install refrigeration tubing with horizontal runs sloped 25 mm per 6 m toward condensing units. Space and locate adjustable hangers to drop required to properly support refrigerant piping. Where vertical runs of more than 2 m occur in suction line, risers shall be trapped at bottom. Install piping so that refrigerant or oil cannot drain back into coils from suction line.

E. Install insulation on suction and refrigerant lines. Install pipe sleeves where piping passes through wall, ceiling, or floor. Fill space around the tubing with mastic insulating compound. Install a permanent suction line filter in each compressor suction line with pressure fitting ahead of the filter to facilitate checking of pressure drop through the filter. Insulate and seal penetrations through walk-in cooler or freezer structures to be vapor tight to prevent condensation within light fixtures, switch boxes, junction boxes, or other fittings. Install escutcheon plates at refrigeration and drain lines.

F. Interconnect blower coils with condensing unit.

G. As part of Division 26 electrical work, connect main power to each disconnect, and install interwire power from freezer’s condensing unit to freezer’s blower coil.

3.6 PROTECTING

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure food service equipment is without damage or deterioration at the time of Substantial Completion.

3.7 START-UP

A. Startup Services: Engage factory-authorized service representatives to perform startup services and to demonstrate and train the Government's maintenance personnel as specified below.

1. Coordinate food service equipment startup with service-utility testing, balancing, and adjustments. Do not operate steam lines before they have been cleaned and sanitized.
2. Remove protective coverings and clean and sanitize equipment, both inside and out, and relamp equipment with integral lighting. Where applicable, comply with manufacturer's written cleaning instructions.
3. Test each equipment item for proper operation. Repair or replace equipment that is defective in operation, including units that operate below required capacity or that operate with excessive noise or vibration.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Test motors and rotating equipment for proper rotation and lubricate moving parts according to manufacturer's written instructions.
6. Test water, drain, gas, steam, oil, refrigerant, and liquid-carrying components for leaks. Repair or replace leaking components.

    a. Coordinate calibration, air adjustments, and similar testing of gas-fired equipment with local gas company, if applicable.

7. Train the Government's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance for each food service equipment item.
8. Verify the following for refrigeration systems:

    a. Test refrigeration equipment's ability to maintain specified operating temperature under heavy-use conditions. Repair or replace equipment that does not maintain specified operating temperature.
    b. Adjust controls, including refrigeration circuits, and room air temperature controls.
    c. Verify that all condensers carry an overload protector
    d. Ensure that competent service mechanic is available during first 8 hours of operation.
    e. Verify that all switches, starters, and controls are identified as to function.

9. Review data in the operation and maintenance manuals.
10. Review data in the operation and maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
11. Schedule training with the Government, through Project Director/COR, with at least 7 days' advance notice.

3.8 CLEANING

A. At completion of installation, clean up items of equipment installed by Contractor.

1. Where stainless steel surfaces are disturbed by installation or fabricating process, finish such surface to match adjoining undisturbed surfaces.
2. At the completion of the installation work, run portable polishing machine over stainless steel and buff.
3. Touch-up painted equipment surfaces where as necessary.
4. Before final payment remove all surplus material, false work, temporary structures, including foundations thereof and debris of every nature resulting from his operations, and shall put the site in a neat, orderly, and broom-clean condition.

3.9 FOOD SERVICE EQUIPMENT SCHEDULE

A. General:

1. This Article may list descriptions for equipment items that are not included for the project-specific size of the food service area. Refer to the equipment schedule in the Drawings to identify applicable equipment items.

B. The following food service equipment shall be provided by the Contractor in accordance with the Schedule on the Drawings.

THREE-COMPARTMENT SINK

(OBO Component Code PL040)
(OBO Component Code PL074)
(OBO Component Code CM136)

- 14 gauge type 304 or equal quality stainless steel sink with three individual one piece stainless steel deep drawn bowls, two integral stainless steel drainboards, integral stainless steel backsplash, and integral stainless steel side splash as conditions necessitate, where end of sink meets wall or column
- Raised rolled edge at front and both sides
- Stainless steel tubular legs with front and rear crossbracing and adjustable stainless steel feet
- Grind and polish welds to blend with adjacent surfaces
- Fabricate drainboards to drain to sink compartment
- Splash mounted heavy duty chrome-plated swivel faucet with aerators
- Three leverwastes with overflow, one mounted in each sink compartment
- Sink to accommodate installation of Dishwasher, below
- Refer to elevations and details for additional requirements

THREE-COMPARTMENT SINK

(OBO Component Code PL057)

- 14 gauge type 304 or equal quality stainless steel sink with three individual one piece stainless steel deep drawn bowls, two integral stainless steel drainboards,

integral stainless steel backsplash, and integral stainless steel side splash as conditions necessitate, where end of sink meets wall or column
- Raised rolled edge at front and both sides
- Stainless steel tubular legs with front and rear cross bracing and adjustable stainless steel feet
- Grind and polish welds to blend with adjacent surfaces
- Fabricate drainboards to drain to sink compartment
- Two splash mounted chrome-plated swivel faucets with aerators
- Three lever wastes with overflow, one mounted in each sink compartment
- Punch holes in backsplash for vacuum breaker for Waste Disposer, Heavy Duty Faucet, and Rinse Overspray
- Supply and mount control bracket for Disposer controls
- Install Waste Disposer Cone, in drainboard as shown on Drawing
- Sink to accommodate installation of Dishwasher, below
- Refer to elevations and details for additional requirements

HAND SINK

(OBO Component Code PL046)

- 20 gauge type 304 or equal quality stainless steel sink with one piece stainless steel deep drawn bowl
- Folded paper towel dispenser and liquid soap dispenser factory installed
- Splash mounted chrome-plated gooseneck faucet with wrist handles and aerator
- Integral stainless steel skirt at front and sides of sink with tapered sides
- Chrome-plated P-Trap

SINK

(OBO Component Code PL079)

- 20 gauge type 304 or equal quality stainless steel sink with one piece stainless steel bowl
- Splash mounted chrome-plated gooseneck faucet with wrist handles and aerator

PREP SINK

(OBO Component Code PL047)
(OBO Component Code CM075)

- 14 gauge type 304 or equal quality stainless steel sink with two individual one piece deep drawn stainless steel bowls, two integral stainless steel drainboards, and integral stainless steel backsplash
- Raised rolled edge at front and both sides
- Stainless steel rear enclosure on backsplash as conditions necessitate
- Stainless steel tubular legs with front and rear cross bracing and adjustable stainless steel feet

- Grind and polish welds to blend with adjacent surfaces
- Fabricate drainboards to drain to sink compartment
- One splash-mounted chrome-plated swivel faucet with aerator
- Two lever wastes with overflow, one mounted in each sink compartment
- Refer to elevations and details for additional requirements

MOP SINK & FAUCET

(OBO Component Code PL009)
(OBO Component Code PL010)

- Type 304 or equal quality stainless steel sink with coved corner stainless steel bowl
- Sink size per Drawings, floor mounted to height nominal 250 mm
- Grind and polish welds to blend with adjacent surfaces
- Wall mounted chrome-plated faucet with support rod

RINSE OVERSPRAY

(OBO Component Code PL043)

- Install deck-mounted chrome-plated fixture on Three Compartment Sink
- Hot and cold water mixing faucet
- Wall bracket to support upright
- Pre-assembled flex hose, spring body, overhead spring and spray valve
- Refer to elevations and details for additional requirements

SINK

(OBO Component Code PL078)

- Water station with drip pan and push back glass filler
- Pedestal style glass filler with 1/2" NPT inlet and 1 1/4" drain
- 18 gauge stainless steel drip pan
- 8” nozzle clearance minimum to accommodate pitchers
- Self-closing lever
- Deck mounted installation type

WASTE DISPOSER

(OBO Component Code PL044)

- Stainless steel grind chamber
- Stainless steel and chrome-plated exterior finish
- Enclosed motor housing
- Rubber mounting above grinding chamber
- Support leg as necessary

- Auto-reversing control panel in NEMA 4 or equal stainless steel enclosure with push button controls
- Anti-siphon vacuum breaker mounted on backsplash of Three Compartment Sink
- Cone assembly with removable splash baffle, reversible bowl cover
- Install disposer, cone, and control panel in Three Compartment Sink
- Refer to elevations and details for additional requirements

DISHWASHER, COMMERCIAL

(OBO Component Code PL042)

- Type 304 or equal quality stainless steel top and front panel
- 16 gauge type 304 or equal quality stainless steel tank with electric tank heat
- Hot water or chemical sanitizing; hot water sanitizing preferred
- Internal hot water booster heater, sized to boost water to sanitizing temperature
- Removable stainless steel scrap screen
- Drain water tempering kit as required by code
- Single rack tank; capable of washing approximately 58 racks per hour
- Electric or gas-fired tank heat <electric heat is typically preferred>
- Pressure Regulator where conditions require
- Vent Fan Control interconnected with Condensate Hood
- Right to left operation
- Straight-thru operation, with side openings to accommodate clean / dirty dishtables
- Automatic fill, door-actuated start and automatic drain closure

UNDERCOUNTER DISHWASHER, COMMERCIAL

(OBO Component Code PL060)

- Type 304 or equal quality stainless steel top and front panel
- 16 gauge type 304 or equal quality stainless steel tank with electric tank heat
- Hot water or chemical sanitizing; hot water sanitizing preferred
- Internal hot water booster heater, sized to boost water to sanitizing temperature
- Removable stainless steel scrap screen
- Drain water tempering kit as required by code
- Single rack tank; capable of washing approximately 30 racks per hour
- Sized to fit under Three Compartment Sink drainboard
- Corrosion resistant pump and automatic pumped drain
- Provide two dishracks with machine

CLEAN DISHTABLE

(OBO Component Code CM004)
(OBO Component Code CM046)
(OBO Component Code CM057)

- 14 gauge type 304 or equal quality stainless steel dishtable with integral stainless steel backsplash
- Raised rolled edge at front and left side
- Angled return at right end of backsplash, modified table, and turned down right end on table, sized to fit into Dishwasher, without splashing or leaking
- Stainless steel tubular legs with front and rear cross bracing and adjustable stainless steel feet
- Grind and polish welds to blend with adjacent surfaces
- Fabricate table to drain to Dishmachine
- Refer to elevations and details for additional requirements

DISHTABLE, DIRTY WITH RINSE SINK

(OBO Component Code PL045)
(OBO Component Code PL058)

- Straight-Soil Dishtable, 10-1/2"H backsplash, with pre-rinse sink
- 16 gauge 304 series stainless steel legs with crossrails front to back
- 14 gauge 304 series stainless steel top, includes prerinse basket with slide bar (slide bar only when disposer adapter is specified).
- Accessories:
  Install collar, with 14" x 16" control bracket
  Anti-Siphon vacuum breaker holes

ADJUSTABLE DISH DOLLY

(OBO Component Code CM001)

- One piece, non-corrosive, hi-tensile, reinforced aluminum base
- Plastic-coated extruded aluminum channels
- Adjustable plate adapters appropriate to plate size and style
- Four heavy duty swivel casters, two with brakes
- Extra adjustable adapters
- Vertical corner bumpers

CUP/GLASS RACK DOLLY

(OBO Component Code CM002)

- Non-corrosive, hi-tensile aluminum construction
- Sized appropriately to accommodate glass storage racks
- Four heavy duty swivel casters, two with brakes
- Extra adjustable adapters
- Corner bumpers

CUP/GLASS RACK DOLLY WITH HANDLE

(OBO Component Code CM034)

- Non-corrosive, hi-tensile aluminum construction
- Sized appropriately to accommodate glass storage racks
- Four heavy duty swivel casters, two with brakes
- Chrome-plated spring back push handle
- Extra adjustable adapters
- Corner bumpers

TRAY CART

(OBO Component Code CM035)

- Stainless steel tubular frame
- Medium-duty nominal 230 kg load capacity
- Two 20 gauge type 304 or equal quality stainless steel shelves
- Four swivel casters, two with brakes
- Corner bumpers

SOILED TRAY RACK CARTS, SINGLE

(OBO Component Code CM036)

- Single wide non-corrosive, hi-tensile aluminum racks to fit two stacks of patron trays
- Four heavy duty swivel casters, two with brakes
- Side, rear, top and bottom enclosures in finish as selected by Project Director/COR
- Push handle
- Corner bumpers

SOILED TRAY RACK CARTS, DOUBLE

(OBO Component Code CM056)

- Double wide non-corrosive, hi-tensile aluminum racks to fit two stacks of patron trays
- Four heavy duty swivel casters, two with brakes
- Side, rear, top and bottom enclosures in finish as selected by Project Director/COR
- Push handle
- Corner bumpers

4 SHELF UNIT WITH CASTERS

(OBO Component Code CM003)
(OBO Component Code CM015)

(OBO Component Code CM043)
(OBO Component Code CM052)
(OBO Component Code CM093)

- Shelf unit to be made up of four adjustable stainless steel wire shelves, four stainless steel posts, two heavy duty swivel rubber casters, and two heavy duty swivel rubber casters with brakes
- Shelf size per Drawings
- Provide accessories necessary to assemble and adjust complete shelf unit

5 SHELF UNIT WITH CASTERS

(OBO Component Code CM014)
(OBO Component Code CM054)
(OBO Component Code CM055)
(OBO Component Code CM085)

- Shelving unit sizes per Drawings
- Each shelf unit to be made up of five adjustable chrome-plated wire shelves, four chrome plated posts, two heavy duty swivel rubber casters and two heavy duty swivel rubber casters with brakes
- Provide accessories necessary to assemble and adjust complete shelf unit

OVERSHELF RACK, SORTING

(OBO Component Code CM005)

- Sorting Shelf, wall mounted, traditional design, 42"W, accommodates (2) full size dish racks.
- Shelf, type 300 stainless steel, 16 gauge.
- Brackets, type 300 stainless steel, 16 gauge.

REACH-IN REFRIGERATOR/FREEZER, DOUBLE DOOR

(OBO Component Code CM016)

- Two section dual temp reach-in cabinet
- Half +2 degree C refrigerator
- Half -17 degree C freezer
- Stainless steel interior and exterior
- Exterior digital thermometer
- Provide adequate ventilation for condensing unit
- Half-height solid doors hinged per plan
- Four swivel polyethylene casters, two with brakes
- Six Chrome plated wire shelves behind each half door
- Stainless steel finished back as conditions necessitate
- Cord and plug]

REACH-IN REFRIGERATOR/FREEZER, SINGLE DOOR

(OBO Component Code CM017)

- One section dual temp reach-in cabinet
- Top half +2 degree C refrigerator
- Bottom half -17 degree C freezer
- Stainless steel interior and exterior
- Provide adequate ventilation for condensing unit
- Exterior digital thermometers
- Half-height solid doors hinged per plan
- Four swivel polyethylene casters, two with brakes
- Six chrome plated wire shelves behind each half door
- Stainless steel finished back as conditions necessitate
- Cord and plug

COUNTERTOP REFRIGERATOR, DOUBLE DOOR

(OBO Component Code CM048)

- Two section reach-in countertop +2 degree C cabinet
- Stainless Steel exterior
- White aluminum interior with type 300 or equal quality stainless steel floor
- Three PVC coated wire shelves
- Provide adequate ventilation for condensing unit
- Double pane glass hinged door with magnetic gasket
- Interior lighting
- Low-height legs
- Cord and plug

REFRIGERATION SYSTEM, REFRIGERATOR CONDENSING UNIT (REFRIG. SYSTEM, +2 C)

(OBO Component Code ME004)

- Completely wired, charged and tested, semi-hermetic condensing unit mounted in remote location and coupled with evaporator unit
- Air-cooled or water-cooled refrigeration; water-cooled preferred
- Provide adequate ventilation for condensing unit component of either type of refrigeration
- Conduit assembly between components
- Thermostatic expansion valve
- Solenoid valve
- Temperature control
- Sight glass, Drier
- Pressure Control

- If installed outdoors and if conditions necessitate, provide crankcase heater, low ambient controls, and weather-proof, painted metal housing with hinged, lockable cover

WALK-IN REFRIGERATOR (REFRIG. SYSTEM, +2 C)

(OBO Component Code CM125)
(OBO Component Code ME003)

- Pre-fabricated wall and ceiling panels of urethane foamed-in-place insulation, to be assembled on site
- Pre-fabricated floor panels of urethane foamed-in-place insulation if conditions necessitate
- Assemble panels with locking fit to ensure tight fit at seams
- Box of size and configuration as shown on Drawings
- Nominal 2750 mm high box
- Refrigeration System to serve walk-in
- Exposed Exterior Walls: 20 gauge or equal quality stainless steel
- Unexposed exterior walls finished with stucco-embossed galvanized steel
- Matching metal trim strips and closure panels to adjacent walls and ceiling
- Interior Walls and Ceiling: White Baked-on Enamel
- Interior Floor if conditions necessitate: 14 Gauge or equal quality galvanized steel, depressed into floor finished per foodservice equipment details in Drawings
- Door(s) located and hinged per Drawings, nominal 915 mm x 1980 mm door;
- Center light fixture over door panel
- Entrance Door: Heated window, self-closing hardware, and heavy duty hinges
- Additional framework at door panel to prevent warping
- Digital thermometer wired to exterior door panel
- Aluminum diamond kickplate on both sides of all doors
- Additional light fixtures as required to appropriately light storage space
- Refer to elevations and details for additional requirements

REFRIGERATION SYSTEM, REFRIGERATOR CONDENSING UNIT (REFRIG. SYSTEM, -25 C)

(OBO Component Code ME006)

- Completely wired, charged and tested, semi-hermetic condensing unit mounted in remote location and coupled with evaporator unit
- Air-cooled or water-cooled refrigeration; water-cooled preferred
- Provide adequate ventilation for condensing unit component of either type of refrigeration
- Conduit assembly between components
- Thermostatic expansion valve
- Solenoid valve
- Temperature control
- Sight glass, Drier

- Pressure Control
- Time Clock
- If installed outdoors and if conditions necessitate, provide crankcase heater, low ambient controls, and weather-proof, painted metal housing with hinged, lockable cover]

WALK-IN FREEZER (REFRIG. SYSTEM, -25 C)

(OBO Component Code CM126)
(OBO Component Code ME005)

- Pre-fabricated wall and ceiling panels of urethane foamed-in-place insulation, to be assembled on site
- Pre-fabricated floor panels of urethane foamed-in-place insulation if conditions necessitate
- Assemble panels with locking fit to ensure tight fit at seams
- Box of size and configuration as shown on Drawings
- Nominal 2750 mm high box
- Refrigeration System to serve walk-in
- Exposed Exterior Walls: 20 gauge or equal quality stainless steel
- Unexposed exterior walls finished with stucco-embossed galvanized steel
- Matching metal trim strips and closure panels to adjacent walls and ceiling
- Interior Walls and Ceiling: White Baked-on Enamel
- Interior Floor if conditions necessitate: 14 Gauge or equal quality galvanized steel, depressed into floor finished per foodservice equipment details in Drawings
- Door(s) located and hinged per Drawings, nominal 915 mm x 1980 mm door;
- Center light fixture over door panel
- Entrance Door: Heated window, self-closing hardware, and heavy duty hinges
- Additional framework at door panel to prevent warping
- Digital thermometer wired to exterior door panel
- Aluminum diamond kickplate on both sides of all doors
- Additional light fixtures as required to appropriately light storage space
- Refer to elevations and details for additional requirements

SALAD TOP REFRIGERATOR

(OBO Component Code CM110)

- Refrigerated Counter, Salad Top, two-section, (2) doors
- 16 gauge stainless steel top with (2) 1/6 size pan opening recessed 2" (pans not included)
- Cold pan to have 2BF stainless steel interior
- Plate shelf
- ABS interior sides, stainless steel floor, unfinished ends & back, side-mounted self-contained refrigeration
- Exterior drawer fronts, stainless steel with ABS plastic liner
- Adjustable height casters in lieu of standard legs

- Accessories:
  Stainless steel right end
  Stainless steel left end

REFRIGERATED BOTTLE CHEST

(OBO Component Code CM068)

- Bottle Cooler, slant top, self-contained refrigeration, heavy-duty construction
- (20) cases of 12oz long neck bottle capacity
- (2) sliding stainless steel doors, condensate evaporator
- Stainless steel top & interior, black exterior, 1/4 HP
- NSF, cULus
- All stainless steel exterior finish
- 2 Bin Divider with support brackets
- No Lock (Standard, nc)
- Accessories:
  Low Profile Rollers, 1-5/8", set of (4)

REFRIGERATOR, SNACK DISPLAY CASE

(OBO Component Code CM090)

- Glass door merchandiser refrigerator, 23 cu.ft.
- (1) hinged glass door with lock
- 36°F to 46°F temperature range
- Digital thermostat with LED display
- White aluminum interior with (3) adjustable shelves
- LED lighting
- Top lighted signage panel
- Black powder-coated exterior
- Bottom mount self-contained refrigeration
- (4) casters (2) braked
- 2/3 HP, 115v/60/1-ph, 2.8 amps, cord with NEMA 5-15P, cULus

REFRIGERATOR, DISPLAY, MOBILE

(OBO Component Code CM091)

- Refrigerated Merchandiser, one-section, (3) shelves
- Laminated vinyl exterior, permanent non-peel non-chip black vinyl
- Stainless steel interior
- Low-E thermal glass hinged door
- LED interior lights
- 1/6 HP, 115v/60/1, 2.0 amps, NEMA 5-15P
- Energy Star

- cULus, CSA, CE, UL EPH Classified
- Self-contained refrigeration standard
- Castors, 2-1/2", set of 4
- Five (5) bottle organizer, per shelf
- Two (2) Standard wire shelf

FREEZER, ICE CREAM CHEST

(OBO Component Code CM092)

- Display Freezer, 4.87 Cu. Ft., 3 Basket Capacity
- Clear, curved glass sliding lids
- -18°F to 10°F temperature range
- Easy grip sliding lid handle
- Lid lock and keys
- Lid frame heated to prevent frost or ice build-up
- White painted steel exterior and white powder-coated steel interior
- Internal condensate evaporator pan
- LED lighting
- Cold wall evaporator with adjustable thermostat
- Drain with plug to aid with cleaning
- Removable rubber bumper guards, side grill
- External temperature display
- Casters
- ETL-Sanitation and cETLus listed

REFRIGERATOR, DISPLAY, 2 DOOR MOBILE

(OBO Component Code CM094)

- Glass door merchandiser, swing door refrigerator
- Refrigeration system: self-contained, capillary tube system
- High capacity, factory balanced refrigeration system that maintains cabinet temperatures of 33°F to 38°F (-0.5°C to 3.3°C)
- Electronically commutated evaporator and condenser fan motors
- Bottom mounted condensing unit
- Cabinet construction: Stainless steel exterior
- Interior - Stainless interior liner with stainless steel floor
- Foamed-in-place high density, polyurethane insulation
- Welded, heavy duty steel frame rail, black powder coated
- Frame rail fitted with leg levelers
- Illuminated exterior sign panel
- Double pane thermal insulated glass door assemblies. White powder coated frames
- Self-closing doors. Positive seal, torsion type closure system
- Magnetic door gaskets of one-piece construction, removable without tools for ease of cleaning
- Eight (8) adjustable, heavy duty PVC coated wire shelves

- Four (4) chrome plated shelf clips included per shelf
- Shelf support pilasters made of same material as cabinet interior; shelves are adjustable on 1/2” (13 mm) increments
- LED interior lighting, safety shielded
- Listed under NSF/ANSI Standard 7
- Casters

FREEZER, DISPLAY, 3 DOOR MOBILE

(OBO Component Code CM095)

- Glass door merchandiser, swing door freezer
- Refrigeration system: self-contained, capillary tube system
- High capacity, factory balanced refrigeration system that maintains cabinet temperatures -10°F (-23.3°C)
- Electronically commutated evaporator and condenser fan motors
- Bottom mounted condensing unit
- Automatic defrost system time-initiated, temperature-terminated
- Cabinet construction: Stainless steel exterior
- Interior - Stainless interior liner with stainless steel floor
- Foamed-in-place high density, polyurethane insulation
- Welded, heavy duty steel frame rail, black powder coated
- Frame rail fitted with leg levelers
- Illuminated exterior sign panel
- Triple pane thermal insulated glass door assemblies. White powder coated frames
- Self-closing doors. Positive seal, torsion type closure system
- Magnetic door gaskets of one-piece construction, removable without tools for ease of cleaning
- Twelve (12) adjustable, heavy duty PVC coated wire shelves
- Four (4) chrome plated shelf clips included per shelf
- Shelf support pilasters made of same material as cabinet interior; shelves are adjustable on 1/2” (13 mm) increments
- LED interior lighting, safety shielded
- Listed under NSF/ANSI Standard 7
- Casters

REFRIGERATOR, UNDERCOUNTER, OUTDOOR

(OBO Component Code CM096)

- Deluxe outdoor rated refrigerator, undercounter, self-contained refrigeration
- 32°F to 50°F temperature range
- (5.3) cu. ft. interior volume
- 304 stainless steel construction
- Adjustable digital thermostat
- Heavy duty adjustable wire shelving
- Interior lighting

- Front venting and sealed back
- Factory installed security lock
- Adjustable legs for leveling
- UL certified for outdoor use

REACH-IN REFRIGERATOR, SINGLE DOOR

(OBO Component Code CM097)

- Solid Door Refrigerator, Reach-in, single-section, 24.96 cubic feet
- Self-contained refrigeration digital thermometer
- (3) chrome plated wire shelves, recessed metal door handle, built-in door locks
- Pressure relief valve, solid hinged half height doors
- ABS interior door liners, stainless steel exterior & interior, stainless steel breaker strips
- Top mounted compressor
- 6" polyurethane casters in lieu of standard legs
- cUL, UL, NSF, ENERGY STAR, 1/3 hp
- Self-contained refrigeration system, standard. All components are mounted to the exterior of the cabinet ceiling
- Accessories:
  Additional chrome plated shelf & clips, for refrigerator/freezer

REACH-IN FREEZER, SINGLE DOOR

(OBO Component Code CM098)

- Solid Door Freezer, Reach-in, single-section, 24.96 cubic feet
- Stainless steel interior and exterior
- Self-contained refrigeration digital thermometer
- (3) chrome plated wire shelves, recessed metal door handle, built-in door locks
- Pressure relief valve, solid hinged half height doors
- ABS interior door liners, stainless steel exterior & interior, stainless steel breaker strips
- Top mounted compressor
- 6" polyurethane casters in lieu of standard legs
- cUL, UL, NSF, ENERGY STAR, 1/2 hp
- Self-contained refrigeration system, standard. All components are mounted to the exterior of the cabinet ceiling
- Accessories:
  Additional chrome plated shelf & clips, for refrigerator/freezer

UNDERCOUNTER REFRIGERATOR

(OBO Component Code CM069)
(OBO Component Code CM109)

- Refrigerator, undercounter, self-contained refrigeration
- 33°F to 42°F temperature range
- (5.3) cu. ft. interior volume, electromechanical thermostat, (2) black vinyl-coated full extension shelves (adjustable) & (1) black-vinyl coated floor rack
- (1) hinged door, interior lighting, front vented, self-evaporating condensate pan
- galvanized back & base, stainless steel top, sides, & interior
- R1/6 HP, ETL-Sanitation, cULus
- Casters, 3-3/4", includes mounting platform (set of 4)
- Accessories:
  Door finish: solid stainless steel
  Right hinged

ICEMAKER, AIR COOLED

(OBO Component Code PL048)

- Capacity – 120 KG
- Stainless steel evaporator and exterior
- Air-cooled or water-cooled condensing unit; air-cooled preferred
- Adequate ventilation must be provided for the condensing unit
- Produces individual ice cubes automatically dispensed into Ice Bin
- Antimicrobial protection
- Mount icemaker on Ice Bin, providing accessories necessary for a seamless fit
- Water Filtration Kit

ICE BIN

- Stainless steel exterior with polyethylene bin liner
- Insulated construction
- Stainless steel legs
- Mount one Ice Maker, on ice bin

ICEMAKER, AIR COOLED, LARGE

(OBO Component Code PL059)

- Capacity – 230 KG
- Stainless steel evaporator and exterior
- Air-cooled or water-cooled condensing unit; air-cooled preferred
- Adequate ventilation must be provided for the condensing unit
- Produces individual ice cubes automatically dispensed into Ice Bin
- Antimicrobial protection
- Mount icemaker on Ice Bin, providing accessories necessary for a seamless fit
- Water Filtration Kit

ICE BIN

- Stainless steel exterior with polyethylene bin liner
- Insulated construction
- Stainless steel legs
- Mount one Ice Maker, on ice bin

ICE WELL

(OBO Component Code CM099)

- Stainless Steel Underbar Ice Bin with Bottle Holders
- Built-In backsplash and drain for easy clean-up
- Heavy commercial use
- 20 gauge, type 304 stainless steel insulated stainless steel construction
- 1" I.D. drain pipe with 1 1/4" connection and 3" tailpiece
- Galvanized legs with adjustable plastic bullet feet
- NSF Listed

ICE BIN, DROP-IN

(OBO Component Code CM115)

- 20 gauge, 304 stainless steel
- 1” NPT drain tubing
- Stainless steel sliding lid
- 23 lb. ice bin capacity

ICE BIN, MOBILE, WITH CASTERS

(OBO Component Code SQ158)

- Stainless Steel Ice Cart, 125 lb. ice capacity
- Insulated stainless steel ice compartment
- Built-in drain and faucet
- Hinged cover
- Extended push handle
- Corner and handle bumpers
- (2) 5" swivel casters and (2) 8" fixed casters

MULTI RANGE, GAS

(OBO Component Code CM018)

- Restaurant Range with open burners
- split cast iron top ring grates
- (6) 33,000 BTU two-piece cast iron open top Startfire burners at left
- 5/8” thick steel griddle plate
- (2) Thermostatically controlled griddle, add per thermostat, for each 12" section

- Grease trough
- (2) standard ovens with 3 position rack guides with oven rack
- 38,000 Btuh/ 11.13 kW cast iron “H” style oven burner
- Porcelain oven interior, fits standard sheet pans in both directions
- Stainless steel front & sides
- Stainless steel plate rail
- Stainless steel backguard, with removable stainless steel shelf
- Samped drip trays w/ dimpled bottom
- 6" adjustable stainless steel legs
- Gas regulator
- 310,000 BTU, CSA Flame, CSA Star, cCSAus, NSF.
- Accessories:
  3/4" Rear gas connection, including "Tee" in manifold, end cap & cover
  Natural Gas Regulator, 3/4" N.P.T.
  Gas Shut-Off Valve, 3/4" N.P.T.
  Gas Flex Hose with quick disconnect includes restraining device, 3/4" N.P.T. x 60" (verify gas connection)
  6” (152mm) levelling swivel casters (4), w/front locking
  Piezo spark ignition for pilots on griddles

LOW PROFILE BACKGUARD/FLUE RISER, STAINLESS STEELMULTI RANGE, ELECTRIC ALTERNATE

(OBO Component Code CM018)

- Restaurant Range with 10” high performance sealed element burners
- (2) standard ovens with 3 position rack guides with oven rack
- Porcelain oven interior, fits standard sheet pans in both directions
- 33 kW, CE, cCSAus, NSF
- Grease trough
- Stainless steel front & sides
- Stainless steel plate rail
- Stainless steel backguard, with removable stainless steel shelf
- Samped drip trays w/ dimpled bottom
- 6" adjustable stainless steel legs
- Accessories:
  6” (152mm) levelling swivel casters (4), w/front locking

FOUR BURNER RANGE, GAS

(OBO Component Code CM060)
(OBO Component Code SQ280)

- Heavy Duty Range with open burners
- (4) 35,000 BTU two-piece Startfire burners, removable heads
- Standard oven, piezo ignition, drip tray, porcelainized oven interior
- Stainless steel front & sides

- 6" chrome steel adjustable legs
- 180,000 BTU, CSA Flame, CSA Star, NSF.
- Accessories:
  3/4" Rear gas connection, including "Tee" in manifold, end cap & cover
  Natural Gas Regulator, 3/4" N.P.T.
  Gas Shut-Off Valve, 3/4" N.P.T.
  Gas Flex Hose with quick disconnect includes restraining device, 3/4" N.P.T. x 60" (verify gas connection)
  Swivel casters with Polyurethane wheels (non-marking)

LOW PROFILE BACKGUARD/FLUE RISER, STAINLESS STEELFOUR BURNER RANGE, ELECTRIC ALTERNATE

(OBO Component Code CM060)
(OBO Component Code SQ280)

- Heavy Duty Range with (2) 18” boiler elements
- 18.5 kW, cCSAus, NSF
- Standard oven, 4-position rack glides, (1) rack
- Stainless steel front & sides
- 6" chrome steel adjustable legs
- Thermostatic controls, 3” H vent riser
- Accessories:
  Swivel casters with Polyurethane wheels (non-marking)

GRIDDLE TOP RANGE, GAS

(OBO Component Code CM062)

- Heavy Duty Range, griddle, thermostatic controls
- 1" (25mm) thick, 99,000 BTU (29 kW) total griddle top
- Standard oven, piezo ignition, drip tray, porcelainized oven interior
- Stainless steel front & sides
- Swivel casters with Polyurethane wheels (non-marking)
- 139,000 BTU, CSA Flame, CSA Star, NSF.
- Accessories:
  3/4" Rear gas connection, including "Tee" in manifold, end cap & cover
  Gas Shut-Off Valve, 3/4" N.P.T.
  Gas Flex Hose with quick disconnect includes restraining device, 3/4" N.P.T. x 60" (verify gas connection)
  Low Profile Backguard/Flue Riser, stainless steel

GRIDDLE TOP RANGE, ELECTRIC ALTERNATE

(OBO Component Code CM062)

- (1) 36” electric griddle

- Thermostatic controls
- Standard oven, 4-position rack glides, (1) rack
- 3” H vent riser
- 21.5 kW, cCSAus, NSF
- Stainless steel front & sides
- Accessories:
  Swivel casters with Polyurethane wheels (non-marking)

FRYER WITH FILTER, GAS

(OBO Component Code CM019)

- One nominal 20 ltr high efficiency fryer, floor model with solid state controllers, melt cycle, stainless steel pot and door, enamel sides batteried together per Drawings with one matching spreader cabinet with stainless steel top and door
- Stainless steel exposed sides on battery
- Four casters for battery, two with brakes
- Self-contained filter system located below fryer for automatic, hands-off filtration
- Two twin size wire baskets for fryer
- Frypot cover
- Electric or gas-fired; gas-fired preferred
- Cord and plug for filter
- Flexible conduit for electric fryer

FOOD WARMER AND HOLDING STATION

(OBO Component Code CM050)

- Stainless steel exposed sides on battery
- Four casters for battery, two with brakes
- Integral fry dump station and rod-style food warmer heat lamp, cord & plug
- stainless steel scoop-type pan

COMMERCIAL MICROWAVE OVEN

(OBO Component Code CM045)

- Stainless Steel Cabinet and Cavity
- Nominal 1200 Watts
- Programmable memory
- Multiple Power Levels
- Interior Oven Light
- See-Through Oven Door
- Touch Control Keypad
- Cord and plug

80 LITER TILTING KETTLE, ELECTRIC

(OBO Component Code CM047)

- Type 304 or equal quality stainless steel construction with stainless steel tubular leg base and adjustable flanged feet
- 2/3 Steam Jacket, with jacket permanently filled with treated, distilled water
- Solid State Controls for Temperature and Low Water Safety
- Tilt Mechanism
- Type 316 or equal quality stainless steel kettle liner for high acid food products
- Spring-assisted, hinged stainless steel cover
- Hot and Cold Water Faucet with Swing Spout
- Electric or gas-fired; gas-fired preferred

DOUBLE CONVECTION OVEN, GAS

(OBO Component Code CM058)

- Convection Oven, gas, double-deck, standard depth
- 66 degree C (150 degree F) to 260 degree C (500 degree F) temperature range and electromechanical timer
- Direct spark ignition with 100% safety shutoff
- 2-speed fan control (high & low) w/3/4HP fan motor
- Total of 60,000 BTU (17.6 kW) loading per oven cavity
- Dependent 60/40 doors with double pane thermal windows in both doors
- Stainless steel front, sides & top, porcelain cavity
- 24" cooking cavity height, with (6) chrome plated oven racks on 13-position rack guides
- Low profile casters with front brakes (set of four)
- UL, cUL, NSF.
- Accessories:
  Direct Connect Vent
  Gas Flex Hose with quick disconnect includes restraining device, 3/4" N.P.T. x 60" (verify gas connection)

DOUBLE CONVECTION OVEN, ELECTRIC ALTERNATE

(OBO Component Code CM058)

- Convection Oven, electric, double-deck, standard depth
- 66 degrees C (150 degrees F) to 260 degrees C (500 degrees F) temperature range and
  electromechanical timer
- 2-speed fan control (high & low) w/3/4HP fan motor
- 20.8 kW UL, cUL, NSF
- Dependent 60/40 doors with double pane thermal windows in both doors
- Stainless steel front, sides & top, porcelain cavity

- 24" cooking cavity height, with (6) chrome plated oven racks on 13-position rack guides
- Low profile casters with front brakes (set of four)
- Accessories:
  Direct Connect Vent

SALAMANDER BROILER, GAS

(OBO Component Code CM067)

- Range mounted on flue riser with high shelf
- (2) 20,000 BTU infrared burners with Hi-Lo valve controls each
- (3) position spring balanced rack assembly
- Removable grease pan
- Stainless steel top, front, sides, backsplash & bottom with heat shields
- Electric or gas-fired; gas-fired preferred

WET-CHEMICALFIRE SUPPRESSION SYSTEM

(OBO Component Code CM037)

- Wet chemical system, actuated in the event of fire, supplied and installed according to codes
- Stainless steel enclosure with cover for agent tank, release and regulator mechanisms, mounted flush against finished ceiling
- Enclosure for system located per Drawings
- Pre-engineered system lines and nozzles to be factory installed by manufacturer of Exhaust Hood
- Piping to hoods shall be above finished ceiling down to hood
- Exposed piping and fittings over the cooking equipment shall be stainless steel or chrome-plated
- System designed for overlapping coverage of all appliances under the hood
- Remote manual actuation device located per Drawings and code
- Locate mechanical gas line shut-off valve beneath hood if gas-fired equipment,
- Pressure switch to shut-off electrical power to any electricity connected to equipment located beneath the hood

EXHAUST HOOD

(OBO Component Code CM038)

- Hood size per Drawings
- Number of hood sections: One
- System to serve equipment below, as indicated on drawings
- 1.27 mm (18 gauge) Type 300 or equal quality polished stainless steel, fully welded airtight construction, with no pop riveting
- Grind and polish welds to blend with adjacent surfaces

- Full access through front removable panels
- Balancing dampers
- Welded exhaust duct collar with connection flange
- Full length adjustable extraction baffles within exhaust plenum
- Light switch located on hood
- Four LED light fixtures wired in conduit to common junction box located on top of hood
- Stainless steel removable enclosure panels from top of hood to underside of ceiling.
- Integral piping for Surface Fire Suppression System
- Hanging brackets
- Refer to elevations and details for additional features and installation information

CONDENSATE HOOD

(OBO Component Code CM006)

- Hood size per Drawings
- Condensation extraction only through internal baffles
- 18 gauge or equal quality polished stainless steel fully welded airtight construction, with no pop riveting
- Grind and polish welds to blend with adjacent surfaces
- Welded exhaust duct collar with connection flange
- Full perimeter condensate channel with drain to Soiled Dishtable/Three Compartment Sink
- Hanging brackets
- Refer to elevations and details for additional requirements

WORKTABLE WITH SINK AND BACKSPLASH

(OBO Component Code CM086)

- 14 gauge type 304 or equal quality stainless steel top with sound deadening, integral stainless steel backsplash, and rolled rim on front and sides
- Table size per Drawings
- 18 gauge or equal quality stainless steel undershelf with turned down edges
- Integral stainless steel one piece deep drawn sink bowl, with swing spout, aerator, and lever waste with overflow
- Stainless steel tubular legs with full cross bracing and adjustable feet
- Grind and polish welds to blend with adjacent surfaces
- Refer to elevations and details for additional requirements]

CHEF'S COUNTER W/ SINK & OVERSHELF

(OBO Component Code CM051)
(OBO Component Code CM061)

- Custom counter per Drawings
- 16 gauge or equal quality stainless steel top
- 22 gauge or equal quality stainless steel back, left and right ends
- 22 gauge or equal quality stainless steel bottom and intermediate shelves with turned down edges
- Integral stainless steel one piece deep drawn sink bowl, with swing spout, aerator, and lever waste with overflow
- Round stainless steel adjustable legs
- Hot Food Wells to accommodate three standard rectangular pans
- Hot Food Well drains manifolded to gate valve
- Individual infinite temperature control for each Hot Food Well
- Integral section of counter shall have +2 degree C refrigerated base with one solid stainless steel door, hinged per Drawings, and raised rail with refrigerated opening sized for multiple ingredient pans
- Provide adequate ventilation for condensing unit
- Stainless steel removable lid over opening in raised rail
- Solid stainless steel access door in front of sink
- Single 18 gauge or equal quality stainless steel overshelf spanning counter, with enlarged section at Microwave Oven
- Rectangular Heat Lamp mounted under overshelf above Hot Food Wells
- Mount infinite control switch for heat lamp on chef's side of counter, with wiring from heat lamp run through overshelf upright
- One convenience tombstone with multiple receptacles mounted on countertop
- Delete backsplash, provide 900 turndown
- Grind and polish welds to blend with adjacent surfaces
- Refer to elevations and details for additional requirements

CHEF'S COUNTER W/ SINK & OVERSHELF, SMALL

(OBO Component Code CM107)

- Custom counter per Drawings
- 16 gauge or equal quality stainless steel top
- 22 gauge or equal quality stainless steel back, left and right ends
- 22 gauge or equal quality stainless steel bottom and intermediate shelves with turned down edges
- Integral stainless steel one piece deep drawn sink bowl, with swing spout, aerator, and lever waste with overflow
- Round stainless steel adjustable legs
- Integral section of counter shall have +2 degree C refrigerated base with one solid stainless steel door, hinged per Drawings, and raised rail with refrigerated opening sized for multiple ingredient pans
- Provide adequate ventilation for condensing unit
- Stainless steel removable lid over opening in raised rail
- Solid stainless steel access door in front of sink

- Single 18 gauge or equal quality stainless steel overshelf spanning counter, with enlarged section at Microwave Oven, Item B36
- One convenience tombstone with multiple receptacles mounted on countertop
- Delete backsplash, provide 900 turndown
- Grind and polish welds to blend with adjacent surfaces
- Refer to elevations and details for additional requirements

COUNTER WITH BACKSPLASH

(OBO Component Code CM074)

- Custom counter per Drawings
- 14 gauge type 304 or equal quality stainless steel top with 5"H backsplash and sound deadening and rolled rim on all edges
- 22 gauge or equal quality stainless steel bottom and intermediate shelves with turned down edges
- Round stainless steel adjustable legs
- Grind and polish welds to blend with adjacent surfaces
- Refer to elevations and details for additional requirement

CONVERTIBLE HOT/COLD PAN, 3 PAN

(OBO Component Code CM023)

- Stainless steel construction to accommodate three standard rectangular pans
- One-piece pan sloped or creased to drain
- Remote control panel with 3-way hot/cold/off power switch and thermostat for hot operation
- Provide adequate ventilation for condensing unit
- Mount in Service Counter, with controls mounted on counter face at chef’s side
- Coordinate installation with millwork
- Refer to elevations and details for additional requirements

CONVERTIBLE HOT/COLD PAN, 2 PAN

(OBO Component Code CM024)

- Stainless steel construction to accommodate two standard rectangular pans
- One-piece pan sloped or creased to drain
- Remote control panel with 3-way hot/cold/off power switch and thermostat for hot operation
- Provide adequate ventilation for condensing unit
- Mount in Service Counter, with controls mounted under island behind an access panel
- Coordinate installation with millwork

- Refer to elevations and details for additional requirements

ROUND HOT FOOD WELL

(OBO Component Code CM049)

- Food Warmer, top-mount, built-in, electric, for 11-quart round insert, drain, wet/dry operation, thermostatic control, fully insulated, stainless steel construction, UL, cULus, NSF
- Controls mounted under island behind an access panel
- Coordinate installation with millwork
- Refer to elevations and details for additional requirements

SLICER

(OBO Component Code CM007)

- Angle-feed 2-speed manual slicer with automatic carriage and adjustable low fence
- Stainless steel knife
- Top mounted stone sharpener
- Food Chute
- Cord and plug

MIXER

(OBO Component Code CM008)

- Tabletop planetary mixer
- Heavy duty motor
- Nominal 19 Ltr Capacity Bowl with appropriately sized beater and wire whip
- Three fixed speeds, plus stir speed
- 15-Minute Timer
- Automatic Time Recall
- Swing-Out Bowl
- Attachment Hub to accommodate future accessories
- Open Base
- Stainless Steel Bowl Guard
- Cord and plug

MOBILE EQUIPMENT STAND

(OBO Component Code CM009)

- Sized to accommodate both Slicer, and Mixer
- 14 gauge type 304 or equal quality stainless steel top with sound deadening
- 18 gauge or equal quality stainless steel undershelf
- Stainless steel tubular legs

- Four swivel rubber casters, two with brakes
- Grind and polish welds to blend with adjacent surfaces

MOBILE WORKTABLE WITH BACKSPLASH

(OBO Component Code CM010)
(OBO Component Code CM012)

- Sized per Drawings
- 14 gauge type 304 or equal quality stainless steel top with 5"H backsplash and sound deadening and rolled rim on all edges
- 18 gauge or equal quality stainless steel undershelf with turned down edges
- Stainless steel tubular legs
- Four swivel rubber casters, two with brakes
- Grind and polish welds to blend with adjacent surfaces

MOBILE WORKTABLE WITHOUT BACKSPLASH

(OBO Component Code CM011)
(OBO Component Code CM100)

- Sized per Drawings
- 14 gauge type 304 or equal quality stainless steel top with sound deadening and rolled rim on all edges
- 18 gauge or equal quality stainless steel undershelf with turned down edges
- Stainless steel tubular legs
- Four swivel rubber casters, two with brakes
- Grind and polish welds to blend with adjacent surfaces

MOBILE WORKTABLE

(OBO Component Code CM063)

- 14 gauge type 304 or equal quality stainless steel top with sound deadening, integral stainless steel backsplash, and rolled rim on all edges
- Table size per Drawings
- 18 gauge or equal quality stainless steel undershelf with turned down edges
- Stainless steel tubular legs with full cross bracing
- Four swivel rubber casters, two with brakes
- Grind and polish welds to blend with adjacent surfaces
- Refer to elevations and details for additional requirements

TOASTER

(OBO Component Code CM025)

- Stainless steel construction with stainless steel conveyor

- High product entry opening
- Sized to accommodate population
- Cord and plug

HOT CUP/ CONDIMENT DISPENSER

(OBO Component Code CM029)

- Stainless steel countertop cabinet to horizontally hold three adjustable cup dispensers of varying diameters and three adjacent compartments for lids and stirrers

COFFEE DISPENSER

(OBO Component Code CM030)

- Matches Coffee Brewer, with brew through lid
- Thermal insulation to maintain coffee temperature for multiple hours

COFFEE BREWER

(OBO Component Code PL050)

- Automatic brewing directly into Coffee Dispenser
- Single dispenser capacity
- Hot Water dispensing faucet
- Sized to accommodate population

COFFEE BREWER, TWIN

(OBO Component Code PL054)

- Automatic brewing directly into Coffee Dispenser
- Dual dispenser capacity
- Hot Water dispensing faucet
- Sized to accommodate population

WATER FILTER, DOUBLE

(OBO Component Code PL051)

- Water Filtration System, twin configuration.
- Rated NSF Class 1, STD 42, for taste, odor and chlorine reduction
- Mechanical filtration (99.9+% removal of particles 1/2 micron and larger in size.)
- Also takes out cysts with sub-micron filtration.
- Max. Flow Rate: 4 gpm, Working Pressure: 10 – 125 psi, Temperature: 35 – 100°F, Capacity: 42,000 gal

WATER FILTER

(OBO Component Code PL052)

- Water Filtration System, single configuration.
- Rated NSF Class 1, STD 42, for taste, odor and chlorine reduction
- Mechanical filtration (99.9+% removal of particles 1/2 micron and larger in size.)
- Also takes out cysts with sub-micron filtration.
- Max. Flow Rate: 2 gpm, Working Pressure: 10 – 125 psi, Temperature: 35 – 100°F, Capacity: 21,000 gal

JUICE DISPENSER

(OBO Component Code CM059)

- 4-Flavor Cold Beverage System, (3) 12 oz. drinks/min capacity
- 2-modular quick dispense decks with 1.0 to 1.5oz (29.6 to 44.4ml) per second flow rate
- 18 lb. ice bank capacity
- 7" cup clearance
- Pumps & mixes 2+1 to 11+1 concentrated beverages, 4+1 high viscosity & 5+1 juices, dispenses cold water, frozen and ambient products
- Push button and portion control, cold water dispense, door lock, juice display
- 120v/60/1-ph, 6amps, NEMA 5-15P, NSF, ETL.

DRAINBOARD

(OBO Component Code CM071)
(OBO Component Code CM072)

- Underbar Drainboard, embossed stainless steel top, Stainless steel drain socket
- 6"H backsplash, 6" rear deck
- Stainless steel legs with adjustable thermoplastic feet
- Stainless steel construction, NSF

BLENDER

(OBO Component Code CM073)

- High Performance Blender
- Two speed motor
- 64 oz. capacity, stackable polycarbonate container
- Variable timer, jump cycle, pulse switch, auto shutoff
- Jar pad sensor
- Stainless steel blades, 3 Hp, cULus, NSF

ESPRESSO MACHINE

(OBO Component Code CM116)

- Two group automatic espresso machine 60 hertz, 220-240V, 4,700 watts
- Stainless steel construction with top storage area for espresso cups
- Minimum four programmable settings per group head with continuous flow option
- Hot water outlet and two steam wands
- Minimum 3.25 gallon stainless steel heat exchange boiler
- Steam and pressure gauges
- (1) single portafilter and (2) double portafilters
- 1/2" water connection, hardwired, ETL US & Canada, NSF listed

PASTRY CASE

(OBO Component Code CM117)

- Three tier acrylic bakery display case
- Slanted front with rear door for full attendant service
- Three clear acrylic trays

DOUBLE SIDED BREATH PROTECTOR

(OBO Component Code CM032)

- Custom food shield per elevations and details
- Tubular construction with finish as selected by Project Director/COR
- Adjustable front tempered glass panel
- Fixed tempered glass panel on top of each side with lights and slimline heat lamps below
- Matching end panels as required by code
- Mounted on Service Island
- Wiring for lights and heat lamps to run through protector case upright to manufacturer-provided switches mounted under counter behind access panels
- Coordinate installation with millwork
- Refer to elevations and details for additional requirements

BREATH PROTECTOR

(OBO Component Code CM033)

- Custom food shield per elevations and details
- Tubular construction with finish as selected by Project Director/COR
- Adjustable front tempered glass panel
- Fixed tempered glass panel on top to form pass shelf with lights and slimline heat lamps below
- Mounted on Service Counter

- Wiring for lights and heat lamps to run through protector case upright to manufacturer-provided switches mounted on counter face on chef's side
- Coordinate installation with millwork
- Refer to elevations and details for additional requirements

BREATH PROTECTOR, SNEEZEGUARD

(OBO Component Code CM118)

- Custom food shield per elevations and details
- Tubular construction with finish as selected by Project Director/COR
- Fixed tempered glass front and end panel
- Open on top
- Mounted on Servery Counter
- Coordinate installation with millwork
- Refer to elevations and details for additional requirements

C. OFOI Equipment Types: Please refer to the SRP-Ms for coordination of food service equipment which will be furnished and installed by others in accordance with the SRP-M Schedules on the Project Documents.

END OF SECTION 114000

SECTION 115355 – CLASS I BIOLOGICAL SAFETY CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Class I Biological Safety Cabinets.

B. Related Sections include the following:

1. Section 133435 “Mail Screening Facilities” for location and coordination of cabinet installation.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings.

C. Installation Instructions.

D. Operations and Maintenance Manual.

1.3 QUALITY ASSURANCE

A. Safety Glass: Products complying with testing requirements in 16 CFR 1201 for Category II materials.

1. Subject to compliance with requirements, permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to Project Director/COR based on input from OBO/PDCS/DE.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 DELIVERY

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install Class I Biological Safety Cabinet until mail screening facility is enclosed, utility roughing-in is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide units which are comparable to the following:

1. Purifier Class I Safety Enclosure, model number 3980323, as manufactured by Labconco Corporation.

2.2 CLASS I BIOLOGICAL SAFETY CABINETS

A. Purifier Class I Safety Enclosure designed for work with agents that require Biosafety Level 1, 2 or 3 containment, but no product protection. Provide with the following specifications and features:

1. Size: approximately 0.9m wide x 0.7m deep x 0.9m high.
2. Sash Opening: 0.2m.
3. Tempered safety glass sides
4. Angled pivoting sash with prop bar - hinged
5. Electrical Specification: 230 volts, 50 Hz, 1.5 amps, International. (Match local power, voltage phase, and frequency)
6. Power Cord & Plug: 230 volts, 10 amps, no plug.
7. Exhaust Volume: 165-230 CFM.
8. Nominal inflow velocity of 90 fpm
9. HEPA filter rated 99.99% efficient on 0.3 micron particles
10. Airflow alarm
11. Two-light filter condition indicator, with audible alarm.
12. Spring-loaded filter clamps
13. Variable speed motor/blower with solid state control rated for 10 amps
14. Blower switch
15. Aerodynamic air foil
16. Protective upper panel/baffle
17. Utility ports with plugs
18. Lighting: Fluorescent lights and 254nm UV light
19. 3-way light switch: UV, off, and fluorescent
20. Epoxy-coated steel and aluminum construction.
21. 100 percent exhaust canopy connection with 150 mm (6 inch) diameter exhaust collar (Manufacturer's PVC or stainless steel through-wall ducting)

22. Exhaust duct out of building with weather protection
23. One spare HEPA filter.
24. Maintenance manual and illustrated parts breakdown

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Safety Cabinets.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. See Section 133435 “Mail Screening Facilities” for installation at the walls of those facilities.

B. Comply with requirements in Division 26 Sections for installing electrical devices and wiring. Securely anchor conduit to Safety Cabinets, unless otherwise indicated.

3.3 ADJUSTING AND CLEANING

A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

B. Clean finished surfaces, including both sides of glass; touch up as required; as accepted by Project Director/COR.

END OF SECTION 115355

SECTION 115700 – SHOP EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes shop equipment and accessories for Facility Management Shops and Vehicle Maintenance Bays as identified in Construction Drawings.

B. Related Sections include the following:

1. Division 03 Section on “Cast-in-Place Concrete” for rough-in interface as required for equipment.
2. Division 10 Section on “Metal Storage Shelving” for metal shelving, cabinets, and racks associated with shop spaces.
3. Division 10 Section on mobile storage shelving for high density rolling shelving.
4. Division 10 Section on “Safety Storage Cabinets” for special cabinets used to store small quantities of flammable or similar material.
5. Division 12 Section on “Work Benches” for benches associated with shop spaces.
6. Division 14 Section on “Vehicle Lifts.”
7. Division 22 Sections related to plumbing system for piping, connections, and other plumbing materials required to complete shop equipment installation.
8. Division 22 or 11 Sections related to general-service compressed-air systems, including air compressors and compressed-air piping that serves both Vehicle Maintenance Bays and selective Shop spaces.
9. Division 22 Sections on washing machine outlet box.
10. Division 23 Sections related to general HVAC system, including for ventilation, required to complete shop equipment installation.
11. Division 26 Sections for electrical system for connections to wiring between starters, disconnects, wall receptacles, and other electrical materials required to complete shop equipment installation.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer’s product information, specifications, and installation instructions for each item of equipment furnished. Confirm power compatibility as indicated.

B. Rough-In Drawings: Provide rough-in drawings for mechanical and electrical services.

C. Shop Drawings: Provide drawings showing, in large scale, methods of construction, joining, dimensions, materials, thicknesses, finishes of materials, installation, relation to adjoining work, and all other details to fully illustrate the work.

D. Connection Drawings: Submit complete and coordinated set of documents for plumbing, mechanical, and electrical connection information.

1. Indicate connections to power for all electrical-based equipment listed within this Section and Division 14 Section on “Vehicle Lifts”.
2. Coordinate air compressors and accessories, and compressed air system piping and related specialties with Division 22 Section related to general-service compressed-air systems.

E. Operations and Maintenance Manuals: Provide manufacturer’s maintenance and operation manuals for each piece of equipment listed within this section. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include product schedule for each equipment item with the following data:

1. Designation indicated on Drawings.
2. Manufacturer’s name and model number.
3. Voltage/Phase/Frequency (Hz).
4. List of factory-authorized service agencies, including addresses and telephone numbers.
5. Manufacturer recommended spare parts list.

1.3 QUALITY ASSURANCE

A. Single Subcontractor Responsibility: The work of this Section shall be the responsibility of one subcontractor.

B. Materials and equipment shall be standard products of manufacturer regularly engaged in manufacture of products that are of similar material, design, function, and workmanship.

C. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.

D. Occupational Safety and Health Act (OSHA): The intent is for shop equipment to conform closely with OSHA requirements. Variations from OSHA requirements shall be limited in extent and degree.

E. Pre-installation Conference: Conduct conference at Project site.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Equipment delivered and placed in storage shall be stored with protection from weather, humidity, temperature variation, dirt and dust, or other contaminants.

B. Prior to shipping from factory each item of shop equipment shall bear identification with manufacturer's name and model number. For major equipment, refer to identification requirements in Part 3 of this Section.

C. Protect machines, tools, parts, and similar components damage due to handling or exposure. Lubricate machine parts, and coat exposed surfaces with thin layer of oil.

D. Take adequate precautions to prevent damage to small tools, parts, and similar items due to oxidation. Coat machined surfaces of small parts or similar components with suitable lubricant.

1.5 COORDINATION

A. Coordinate shop equipment layout and installation with other work, including layout and installation of lighting fixtures, HVAC equipment, electrical, plumbing, and air compressor distribution system and fire-suppression system components.

B. Coordinate locations and requirements of utility service connections.

C. Coordinate sizes, locations, and requirements of the following:

1. Overhead equipment supports.
2. Equipment bases.
3. Floor depressions.
4. Floor areas with positive slopes to drains.
5. Floor-mounted sinks.
6. Roof curbs, equipment supports, and penetrations.
7. Compressed air connections.
8. Voltage/Phase/Frequency (Hz).

1.6 EXTRA MATERIALS

A. Furnish general extra materials identified in this Article, and those identified with specific equipment in Part 2 of this Section. Package each with protective covering for storage, and identify with labels describing contents and identifying associated equipment as applicable.

1. Lubricants: Three sets of lubrication data for each machine. Identify type of lubricant used and frequency of application. Tape one set to associated machine, and deliver other two sets to Project Director/COR.
2. Compressed Air Hose Accessories: One set each of the following for each air hose and reel:

   a. End-barbed style European air chuck.
   b. Serrated shank for 6.35mm (1/4") I.D. hose.
   c. Inflator hose assembly with open-end female style European air chuck; 1.5M (60") long.
   d. Male brass connectors for 6.35mm ((1/4") I.D. (19 BSP) hose; includes European air chuck.
   e. Air Gun Kit, Pistol Grip. Basis of Design; Speedaire Model 22YK43. Inlet size of 6.35mm (1/4 inch) (F)NPT. Outlet size of M14 x 25.4mm (1 inch) (F)NPT. Air consumption of 8 scfm.

3. Plugs with Cords:

a. Basis of Design: Hubbell HBL5466C.
b. Provide one 20 A and one 15 A cord plug cap for each duplex receptacle.
c. Provide two for each quadruplex receptacle installed shop spaces.
d. Plug caps shall be of grounding types, utilizing only screw terminals for terminating conductors.
e. Tape one set to machine, and deliver other two to Project Director/COR.

PART 2 - PRODUCTS

2.1 SAFEGUARD FEATURES

A. General:

1. Provide equipment with safeguard features consistent with Occupational Safety and Health Act (OSHA) Standards - 29 CFR.

a. Guards: Provide belt guards, eye shield guards at wheels of grinders, guards at front of drill press spindles, finger guards at printing presses, finger guard at cutters, and finger guard at shears. There shall be no exposed set screws or keys on moving parts. Belt gear and chain drives on machines shall be completely enclosed in manner consistent with OSHA requirements.

B. Circular Saw: Circular saws shall be provided with saw guard. Saw guards shall:

1. Include kick back attachment.
2. Be fully adjustable over saw blade so as not to hinder any operations performed, except for dadoing or routing on circular saw.
3. Be capable of acting as hold down device and capable of providing horizontal pressure against rip fence.
4. Be completely installed on circular saws with all necessary brackets, and with locating holes drilled and tapped in saw table.

C. Grinder Wheels: Grinder wheels shall:

1. Be fully enclosed at both sides and around circumference, except at front tool rest. Enclosure shall either use manufactured cast iron casing or use fabrication of 2.7 mm (No. 12 USS gage) sheet steel properly formed, either riveted or welded together to suit conditions. Securely bolt enclosure to machine frame. Provide guard with hinged-and-latched or removable side piece at spindle end; fasten with self-tapping screws set into double thickness of metal in manner to facilitate easy removal or replacement of grinding wheel.
2. Be provided with shatter-proof glass (not wire glass) eye shield, 127 x 1778 mm (5 x 7 inch) size, in metal frame with adjustable bracket arm. Arm shall be long enough to locate eye shield directly in front of grinding wheel face. Securely fasten arm to machine frame.

D. Lockup Devices: For equipment operated by foot treadle, provide lockup device. Device shall:

1. Consist of proper length of steel machine chain No. 3, welded straight link.
2. Include cast bronze padlock, 38 mm (1-1/2 inch) size, keyed for use with size No. 47 key. Deliver two keys with each lock.
3. Have padlock and chain securely fastened to each other and to machine by riveted fastenings in such location and arrangement that operating lever or treadle can be securely locked in place when equipment is not in use.
4. Be furnished for squaring shears, paper cutters, and similar machines.

E. Chuck Keys: Where equipment requires chuck keys, they shall be safety type self-ejecting in lieu of standard chuck keys.

2.2 AIR HOSE REEL (COMPRESSED AIR) (OBO COMPONENT CODE SQ031):

A. Basis-of-Design Product: LINCOLN Model 83753 or equivalent product.

B. Minimum Characteristics:

1. Reel Type: Spring driven, automatic rewind with ratchet mechanism (eight locking positions per revolution).
2. Connectors: Brass.
3. Length: 15 m (50 feet) 9.5 mm (3/8”) hose.
4. Incoming air connection: 6.35 mm (¼”) NPT.
5. Hose connections: Male at 6.35 mm (¼”) NPT.
6. Maximum Pressure: 2,068 kPa (300 psi).
7. Maximum Air Flow: 11.8 lps (25 cfm).

2.3 POWER CORD REEL (OBO COMPONENT CODE SQ030):

A. Basis-of-Design Product: Subject to compliance with requirements, provide REELCRAFT model no. L5550 123 X 1 or equivalent product.

B. Power cord reel characteristics and specifications shall be the following (at a minimum):

1. Reel Type: Spring driven, automatic rewind with ratchet mechanism (eight locking positions per revolution).
2. Length: 15 m (50 Feet) cord.

2.4 ADJUSTABLE CLAMP (OBO COMPONENT CODE SQ087):

A. Basis-of-Design Product: Subject to compliance with requirements, provide BESSEY TOOLS model no. BV-HD60 or equivalent product.

B. Adjustable clamp characteristics and specifications shall be the following (at a minimum):

1. Material: Forged alloy steel.
2. Spin Handle: Long length, alloy steel.
3. Base: 360 degree swivel base with two locking handles, alloy steel.
4. Jaws: 152 mm (6 inches) width and opening, serrated.
5. Throat Depth: 75 mm (3 inches).

C. Adjustable clamp shall comply with the following standards:

1. ISO 14001, "Environmental Management System."
2. ISO 9001, "Quality Management Systems – Requirements."

2.5 UTILITY SINK – WITH FAUCET (OBO COMPONENT CODE PL020):

A. Basis-of-Design Product: Product: Subject to compliance with requirements, provide MUSTEE model no. 1RLN8 or equivalent product.

B. Conform to ANSI 124.6. Utility sink and faucet characteristics and specifications shall be the following (at a minimum):

1. Bowl:

a. Color: White.
b. Shape: Square.
c. Size: 609 mm (24 inches) length x 508 mm (20 inches) width x 863 mm (34 inches) height.
d. Bowl Depth: 330 mm (13 inches).
e. Drain Opening: 38 mm (1 ½ inch).

2. Faucet:

a. Color/Finish: Chrome.
b. Operation: Dual handle (lever).
c. Mounting Centers: 100 mm (4 inches).
d. Holes: Two.
e. Flow Rate: 8.33 lpm (2.2 gpm).

2.6 DRILL PRESS – FLOOR (WOOD) (OBO COMPONENT CODE SQ017):

A. Basis-of-Design Product: Subject to compliance with requirements, provide JET model no. J-2550 or equivalent product.

B. Drill press characteristics and specifications shall be the following (at a minimum):

1. Drill Length: 508 mm (20 inches).
2. Motor Size: 1 hp.
3. Motor Speed: 220 – 2,450 rpm (variable speed).

4. Table Surface Dimensions: 457 mm (18 inches) length x 406 mm (16 inches) width.
5. Quill Diameter: 75 mm (3 inches).
6. Voltage and Phase: Conform to host country electrical standards.

C. Extra Materials:

1. One drill bit set (woodworking); minimum 6 mm, 12 mm, and 18 mm diameters.
2. Safety type self-ejecting chuck key in lieu of standard key.
3. One dust collector connector.

2.7 JOINTER – CLOSED STAND (OBO COMPONENT CODE SQ023):

A. Basis-of-Design Product: Subject to compliance with requirements, provide JET model no. JWJ-8CS (718200K) or equivalent product.

B. Jointer characteristics and specifications shall be the following (at a minimum):

1. Cutting Capacity: 203 mm (8 inches) width x 12.7 mm (1/2 inch) depth.
2. Motor Size: 2 hp.
3. Motor Speed: 5,500 rpm (cutting).
4. Number of Knives: 3.
5. Knife Size: 203 mm (8 inches) length x 17.4 mm (11/16 inch) width x 3.17 mm (1/8 inch) height.
6. Table Surface: 229 mm (9 inches) width x 1.83 m (72 inches) length.
7. Voltage and Phase: Conform to host country electrical standards.

C. Extra Materials:

1. One cutter head.
2. One set of three high speed steel knives.
3. One magnetic type knife setting jig.
4. One dust collector connector.

2.8 PLANER – WOODWORKING (OBO COMPONENT CODE SQ022):

A. Basis-of-Design Product: Subject to compliance with requirements, provide JET model no. JPM-13CS or equivalent product.

B. Planer characteristics and specifications shall be the following (at a minimum):

1. Cutting Capacity: 330 mm (13 inches) width x 5 mm to 156 mm thickness x 1.59 mm (1/16 inch) depth.
2. Motor Speed: 4,500 rpm (cutting).
3. Voltage and Phase: Conform to host country electrical standards,

C. Extra Materials:

1. Two replacement drive belts.
2. Two sets of three high speed planer knives.
3. One shaving hood with dust collector connector.
4. One bed and feed roll gauge.
5. One cutterhead gauge.
6. One knife grinding attachment, with indexing mechanism.

2.9 BAND SAW – VERTICAL (OBO COMPONENT CODE SQ018):

A. Basis-of-Design Product: Subject to compliance with requirements, provide JET model no. JWBS-14CS or equivalent product.

B. Band saw shall meet the following characteristics and specifications (at a minimum):

1. Blade Length: 2.37m (93.5 inches).
2. Cutting Capacity: 152 mm (6 inches) x 343 mm (13.5 inches).
3. Motor Size: 3/4 hp.
4. Blade Speed: 3,000 rpm.
5. Voltage and Phase: Conform to host country electrical standards.

C. Extra Materials:

1. One auto miter gage with 60-degree swing both right and left.
2. One rip fence complete with guide bars.
3. One dust collector connector.
4. Five of each of the following new blades to fit machine; these standard blades shall be of required length to fit band saw supplied:

a. 1/4" blade, 5 teeth/inch.
b. 3/8" blade, 5 teeth/inch.
c. 1/2" blade, 4 teeth/inch.
d. 1/4" Skip tooth Blade, 4 teeth/inch.
e. 3/8" Skip tooth Blade, 4 teeth/inch.
f. 1/2" Skip tooth Blade, 4 teeth/inch.

2.10 DUST COLLECTOR – CYCLONIC (OBO COMPONENT CODE SQ019):

A. Basis-of-Design Product: Subject to compliance with requirements, provide ONEDIA model no. Dust Gorilla Pro XGK050055 or equivalent product.

B. Dust collector shall meet the following characteristics and specifications (at a minimum):

1. Motor Size: 5 hp.
2. Airflow Capacity: **[1,625 cfm (designer shall confirm based on project specific equipment)]**.
3. Dust Bin: One 200 L (55 gallon) drum with liner and dolly (portable).
4. Pre-filter: HEPA Grade ePTFE Media (E12 minimum efficiency rating).

5. Stand: Leg extensions shall accommodate 200 L (55 gallon) drum.

C. Dust collector shall be complete, adjusted and ready for use and equipped with the following accessories for equipment connections (at a minimum):

1. One cabinet saw connector and quick disconnect.
2. One jointer connector and quick disconnect.
3. One band saw connector and quick disconnect.
4. One panel saw connector and quick disconnect.
5. One planer connector and quick disconnect.
6. One drill press connector and quick disconnect.

D. Motor for Dust Collector shall have TEFC enclosure and shall be designed to operate on local electrical requirements. Unit shall be fitted with 1800 mm (6 feet) long heavy duty, four conductor (one grounding) cord set and twist-lock plug to match the receptacle. Dust Collector shall be approved for Class II, Division 1, Group G locations as per Article 502 of NFPA 70.

E. Provide in convenient location on Dust Collector a magnetic starter wired to motor with approved materials.

F. Dust collector shall be exhausted to the exterior in accordance to ACGIH Ventilation manual.

G. Extra Materials:

1. One HEPA Grade ePTFE Media (MERV 16+ rated).
2. Three 200 L (55 gallon) plastic bag liners for dust bin.

2.11 CABINET SAW (OBO COMPONENT CODE SQ024):

A. Basis-of-Design Product: Subject to compliance with requirements, provide POWERMATIC model no. PM2000B (kit no. PM25130K) or equivalent product.

B. Cabinet saw shall meet the following characteristics and specifications (at a minimum):

1. Blade Size: 254 mm (10 inches).
2. Table Surface: 1.06 m (42 inches) x 775 mm (30.5 inches) inclusing extension table. Include 762 mm (30 inches) rail set.
3. Motor Size: 5 hp.
4. Motor Speed: 3,450 rpm.
5. Blade Tilt: 0-45 degrees; left.
6. Voltage and Phase: Conform to host country electrical standards.

C. Extra Materials:

1. One 12", 72 tooth carbide tipped blade (trim cut with grain).
2. One 12", 80 tooth carbide tipped blade (trim cut across grain).
3. One 12", 50 tooth carbide tipped blade (combination).
4. One 12", 50 tooth steel combination blade.
5. One dust collector connector

D. Provide a blade safety guard to fit the saw supplied. Safety guard shall comply with OSHA Regulations, Sections 1910-213-C and 1910-213-D.

2.12 PANEL SAW (OBO COMPONENT CODE SQ020):

A. Basis-of-Design Product: Subject to compliance with requirements, provide SAFETY SPEED model no. 7400 or equivalent product.

B. Panel saw shall meet the following characteristics and specifications (at a minimum):

1. Blade Size: 210 mm (8.25 inches).
2. Cutting Capacity: 1.27 m (50 inches).
3. Surface Dimensions: 1.78 m (70 inches) x 1.52 mm (60 inches).
4. Motor Size: 3 hp.
5. Motor Speed: 5,800 rpm.
6. Voltage and Phase: Conform to host country electrical standards.

C. Extra Materials:

1. Three 210 mm (8.25 inch) saw blades.
2. One dust collector connector.

D. Provide a blade safety guard to fit saw supplied. Safety guard shall comply with OSHA Regulations, Sections 1910-213-C and 1910-213-D.

2.13 BELT/DISC SANDER (OBO COMPONENT CODE SQ298):

A. Basis-of-Design Product: Subject to compliance with requirements, provide POWERMATIC model no. 1791291K or equivalent product.

B. Belt/Disc sander shall meet the following characteristics and specifications (at a minimum):

1. Belt Size: 153 mm (6 inches) x 1.22 m (48 inches).
2. Disc Size: 305 mm (12 inches).
3. Tilt: 0, 45, 90 degrees.
4. Motor Size: 1.5 hp.
5. Motor Speed: 2,375 rpm (disc) and 2410 srpm (belt).
6. Voltage and Phase: Conform to host country electrical standards.

C. Extra Materials:

1. Three fine sanding belts.
2. Three coarse sanding belts.
3. Three fine sanding discs.
4. Three coarse sanding discs.
5. One dust collector connector.

2.14 TIRE CHANGER (OBO COMPONENT CODE SQ026):

A. Basis-of-Design Product: Subject to compliance with requirements, provide COATS model no. 60XA or equivalent product.

B. Tire changer shall conform to the following characteristics and specifications (at a minimum):

1. Wheel Size: 610 mm (24 inches) min.
2. Tire Size: 356 mm (14 inches) width x 1.27 m (50 inches) diameter.
3. Motor Type: compressed air at 1.21 MPa (175 psi) / electric.
4. Motor Size: 1.5 hp min.

2.15 TIRE BALANCER (OBO COMPONENT CODE SQ028):

A. Basis-of-Design Product: Subject to compliance with requirements, provide COATS model no. 1300 or equivalent product.

B. Tire balancer shall conform to the following characteristics and specifications (at a minimum):

1. Balancing Modes: 8.
2. Tire Size: 508 mm (20 inches) width x 1.12 m (44 inches) diameter.
3. Motor Type: Electric.
4. Motor Size: 1.5 hp min.
5. Voltage and Phase: Conform to host country electrical standards.

2.16 TIRE RACK (OBO COMPONENT CODE SQ027):

A. Basis-of-Design Product: Subject to compliance with requirements, provide EDSAL model no. TRWS7218 or equivalent product.

B. Tire rack shall conform to the following characteristics and specifications (at a minimum):

1. Dimensions: 1.83 m (72 inches) width x 1.83 m (72 inches) height x 457 mm (18 inches) depth.
2. Material: Heavy-duty steel.

2.17 YOKE PIPE VISE – PORTABLE (OBO COMPONENT CODE SQ096):

A. Basis-of-Design Product: Subject to compliance with requirements, provide RIDGID model no. 40A or equivalent product.

B. Yoke pipe vise characteristics and specifications shall meet the following (at a minimum):

1. Type: Pipe Chain Vise.
2. Pipe Capacity: 3 mm (1/8 inch) to 60 mm (2.5 inches).
3. Integrated ground lug.
4. Rugged tool tray.

2.18 PIPE CUTTER (SH004 PLUMBING AND APPLIANCE REPAIR):

A. Basis-of-Design Product: Subject to compliance with requirements, provide RIDGID model no. 32820-2A or equivalent product.

B. Pipe cutter characteristics and specifications shall meet the following (at a minimum):

1. Cutter Style: Heavy duty pipe.
2. Pipe Capacity: 3 mm (1/8 inch) to 50 mm (2 inches).

C. Extra Materials:

1. Three replacement blades.

2.19 PIPE THREADING MACHINE (OBO COMPONENT CODE SQ098):

A. Basis-of-Design Product: Subject to compliance with requirements, provide RIDGID model no. 1224 or equivalent product.

B. Pipe threading machine characteristics and specifications shall meet be the following (at a minimum):

1. Motor Size: 1.3 hp (universal).
2. Motor Control: Heavy-duty FOR/OFF/REV switch with integral foot switch.
3. Spindle Speed: 36 / 12 rpm (standard).
4. Pipe Capacity: 3 mm (1/8 inch) to 102 mm (4 inches).
5. Bolt Capacity: 6 mm (1/4 inch) to 50 mm (2 inches).
6. Chuck Type: Auto / Hammer.
7. Oil Pump: Self-priming.
8. Cutter: Self-centering, full-floating.
9. Stand: Correspond with RIDGID 200A or equivalent product.

C. Extra Materials:

1. Three replacement blades.

2. Three hammer-type chuck with replaceable rocker-action jaw inserts.

2.20 PIPE REAMER (ACCESSORY TO OBO COMPONENT CODE SQ098):

A. Basis-of-Design Product: Subject to compliance with requirements, provide RIDGID model no. 42365-341 or equivalent product. The pipe reamer is an accessory to the pipe threading machine.

B. Pipe reamer characteristics and specifications shall meet be the following (at a minimum):

1. Pipe Capacity: 3 mm (1/8 inch) to 50 mm (2 inches).
2. Positive locking.
3. 5-flute cone.

2.21 REFRIGERANT RECOVERY UNIT (SH005 HVAC AND ELECTRICAL):

A. Basis-of-Design Product: Subject to compliance with requirements, provide BACHARACH model no. 2020-8001 or equivalent product. The refrigerant recovery unit shall be used with Category III, IV and V Refrigerants only, no explosive, flammable or corrosive coolants.

B. Refrigerant recovery unit characteristics and specifications shall be the following (at a minimum):

1. Type: 2-port.
2. Compressor: Air-cooled.
3. Electrical Connections: NEMA 5-15P Male Plug.
4. Motor Size: 1 hp.

2.22 PVC HEATER – BENDER (OBO COMPONENT CODE SQ097):

A. Basis-of-Design Product: Subject to compliance with requirements, provide GREENLEE model no. 847 or equivalent product.

B. PVC heater-bender characteristics and specifications shall meet the following (at a minimum):

1. Motor Type: Electric.
2. Capacity: 13 mm (1/2 inch) to 152 mm (6 inches).
3. Material: heavy duty metal.
4. Timer.
5. Optional PVC plug.
6. Optional Roller Support.

2.23 CHOP SAW – METAL (OBO COMPONENT CODE SQ036):

A. Basis-of-Design Product: Subject to compliance with requirements, provide M.K MORSE model no. CSM14MB or equivalent product.

B. Chop saw metal characteristics and specifications shall conform to the following (at a minimum):

1. Motor Speed: 1,300 rpm.
2. Blade Diameter: 356 mm (14 inch).
3. Arbor Hole: 25 mm (1 inch).
4. Voltage and Phase: Conform to host country electrical standards.

C. Standard equipment shall be furnished with chop saw and include the following:

1. Safety guard.
2. Mitering vice.
3. 8 mm hex wrench.
4. 6 mm hex wrench.

D. Extra Materials:

1. Two 356 mm (14 inch) metal cutting replacement blades.

2.24 MIG/TIG WELDER (OBO COMPONENT CODE SQ035):

A. Basis-of-Design Product: Subject to compliance with requirements, provide LINCOLN model no. POWER MIG 360MP (K4467-1) or equivalent product.

B. MIG/TIG welder characteristics and specifications shall conform to the following (at a minimum):

1. Output Range: 5 – 360 amps DC.
2. Package: Ready to weld; Educational One-Pak (K4778-1) or equivalent package.
3. Cover: Manufacturer's standard.
4. Options: Wheeled.

2.25 EXTRACTOR ARM – FUME (OBO COMPONENT CODE SQ034):

A. The Basis-of-Design Product: Subject to compliance with requirements, provide EXTRACT-ALL model no. EA76 or equivalent product.

B. Extractor arm characteristics and specifications shall conform to the following (at a minimum):

1. Arm Diameter: 152.4 mm (6 inches).
2. Length: 2.13 m (84 inches).
3. Arm Assembly: Two 0.61 mm (24-gauge) galvanneal steel tubes connected via flex hose and two external joints at the middle joint.
4. Damper: Rotated open and shut via handle on side of arm-standard.
5. Hood: 1.5 mm (16-gauge) steel with 360-degree swivel.
6. Arm support: Sealed gas shock absorber.
7. Exhauster/Blower: Provide blower, compatible with selected extractor arm.
8. Airflow Capacity: **[designer shall confirm based on project specific equipment)]**.

2.26 DRYING AND STORAGE CABINET – CATHODE (OBO COMPONENT CODE SQ088):

A. Basis-of-Design Product: Subject to compliance with requirements, provide LINCOLN model no. K2942-2 or equivalent product.

B. Drying storage cabinet characteristics and specifications shall meet the following (at a minimum):

1. Capacity: 159 kg (350 lbs).
2. Capacity Length: 457 mm (18 inches).
3. Storage Temperature: 38-288 ºC (100-550ºF).
4. Drying Temperature: 38-288 ºC (100-550ºF).
5. Thermostat: adjustable.
6. Voltage and Phase: Conform to host country electrical standards.

2.27 DRILL PRESS – FLOOR (METAL) (OBO COMPONENT CODE SQ279):

A. Basis-of-Design Product: Subject to compliance with requirements, provide JET model no. J-2550 or equivalent product.

B. Drill press characteristics and specifications shall be the following (at a minimum):

1. Drill Length: 508 mm (20 inches).
2. Motor Size: 1 hp.
3. Spindle Speed: 150 – 4,200 rpm (variable speed).
4. Table Surface Dimensions: 470 mm (18.5 inches) length x 419 mm (16.5 inches) width.
5. Quill Diameter: 57 mm (2.25 inches).
6. Voltage and Phase: Conform to host country electrical standards.

C. Extra Materials:

1. One drill bit set (metal); minimum 6 mm, 12 mm, and 18 mm diameters.
2. Furnish one safety type self-ejecting chuck key in lieu of standard key.

2.28 BENCH GRINDER (OBO COMPONENT CODE SQ297):

A. Basis-of-Design Product: Subject to compliance with requirements, provide BALDOR model no. 1021W or equivalent product.

B. Bench grinder shall meet the following characteristics and specifications (at a minimum):

1. Wheel Size: 254 mm (10 inches).
2. Number of Wheels: two.
3. Motor Size: 1.5 hp.
4. Motor Speed: 1,500 to 1,800 rpm.
5. Voltage and Phase: Conform to host country electrical standards.

2.29 PAINT SPRAY BOOTH BENCH (OBO COMPONENT CODE SQ033):

A. Basis-of-Design Product: Subject to compliance with requirements, provide GLOBAL FINISHING SOLUTIONS Model IFP-5 or equivalent product.

B. Paint spray booth bench characteristics and specifications shall conform to the following (at a minimum):

C. Exhaust Fan System: Propeller shall be of balanced, one-piece cast aluminum construction located at the terminus of exhaust duct except if indicated otherwise on Drawing. Coordinate with requirements in Division 23 and Division 26 Sections.

1. Dimensions (Overall): 1.63 m width x 2.18 m height x 1.57 m depth.
2. Dimensions (Working): 1.52 m width x 1.22 m height x 915 mm depth.
3. Light Fixture: One 1,220 mm (48 inch) LED.
4. Fan Size: 457 mm (18 inch).
5. Motor Size: 1/2 hp.
6. Voltage and Phase: Conform to host country electrical standards.
7. Accessories: Manometer; exhaust filter pads with grid retainers.

D. Extra Materials:

1. Provide two sets of filters.

2.30 PAINT MIXER – SHAKER (OBO COMPONENT CODE SQ032):

A. Basis-of-Design Product: Subject to compliance with requirements, provide HERO model no. S2700 or equivalent product.

B. Paint mixer characteristics and specifications shall conform to the following (at a minimum):

1. Load Capacity: 50 kg (110 lbs.).
2. Mixing Capacity: Up to 19 liters (5 gal.).
3. Motor Size: 3/4 hp.
4. Voltage and Phase: Conform to host country electrical standards.
5. Accessories: 7-position quart can adapter and two can pads.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and that installation of equipment and furniture may proceed. Notify the PD/COR in writing of conditions which adversely affect the Work. Do not proceed with installation until conditions have been corrected.

B. Verification of Dimensions: Contractor shall become familiar with all details of the work, verify all dimensions in the field.

3.2 PREPARATION

A. Verify dimensions of supporting structure by field measurements so that equipment work will be accurately designed, fabricated and fitted to the structure. Examine roughed-in mechanical and electrical services, installation of floors, walls, columns, and ceilings, and other conditions under which equipment work is to be installed. Notify Contractor in writing, of any dimensions found to be different than shown. Use Contractor's benchmarks as basis of measurements.

3.3 INSTALLATION, GENERAL

A. Coordinate equipment work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work. Furnish installation templates, diagrams, and other data to fabricators and installers of related work as necessary for coordination of the installation. Place such items, including pipes, conduit, inserts and anchors, accurately in relation to the final location of equipment components.

B. Install all components of the equipment in accordance with the manufacturer's written instructions and recommendations.

C. Verify plumbing, mechanical, and electrical connection requirements for all equipment with manufacturer and coordinate connections with Division 14 Section on “Vehicle Lifts,” and with requirements in Division 22, Division 23, and Division 26 Sections.

D. Paint Spray Booth Exhaust Fan System: Exhaust fan installation with ductwork shall discharge directly outside with minimum static pressure. Conform to requirements of Chapter 5 in the OBO Mechanical Code. Coordinate with general installation requirements in Division 23, and Division 26 Sections.

3.4 IDENTIFICATION

A. Nameplates: Each major equipment item shall have the manufacturer’s name, address, and catalog or serial number permanently affixed to a plate securely attached to the equipment.

3.5 CLEANING

A. After completion of installation and other major construction work in equipment areas, remove protective coverings, if any, and clean equipment, internally and externally. Restore exposed and semi-exposed finishes to remove abrasions and other damages; and touch-up painted surfaces. Replace work that cannot be successfully restored.

B. Final Cleaning: After testing and start-up, and before time of Substantial Completion, clean equipment, and leave in condition ready for use.

3.6 DEMONSTRATION AND TRAINING

A. Contractor shall provide a minimum of 30 minutes of training for each piece of electrically-powered, pneumatic, and mechanically-assisted piece of equipment

3.7 SCHEDULE

A. **[Provide shop equipment as indicated in the shop equipment and furnishing schedule in the Construction Drawings.]**

END OF SECTION 115700

SECTION 117000 - MEDICAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes medical equipment.

B. Government Furnished Equipment (GFE) Responsibility:

1. Medical equipment and accessories that are identified as GFGI (or OFOI) will be furnished and installed by Post separate from this contract.
2. Associated furniture and accessories that are identified as GFCI are included as items of GFE Furniture Installation in Section 125005, “GFE Furniture Installation.”
3. Associated computer and telephone equipment that are identified as GFGI (or OFOI) will be furnished and installed by Post separate from this contract.

1.2 SUBMITTALS.

A. Product Data: Submit manufacturer's product information, specifications, and installation instructions for each item of equipment furnished.

1. Include upholstery, laminate, and all other required finish material samples from the manufacturer’s standard finishes for all equipment.

B. Rough-In Drawings: Provide rough-in drawings for mechanical, electrical, and telecommunications services.

C. Shop Drawings: Provide drawings showing, in large scale, dimensions, materials, thicknesses, finishes of materials, installation, relation to adjoining work, methods of construction and joining, and all other details to fully illustrate the work.

D. Connection Drawings: Submit complete electrical, plumbing, and mechanical connection information and coordinate with Divisions 22, 23, 26, and 27.

E. Maintenance and Operation Manuals: Provide manufacturer's maintenance and operation manuals.

1.3 QUALITY ASSURANCE

A. Single Subcontract Responsibility: Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of products that are of a similar material, design, and workmanship.

B. Nameplates: Each major item of equipment shall have the manufacturer's name, address, and catalog or serial number permanently affixed to a plate securely attached to the equipment, and readily visible.

C. Verification of Dimensions: Contractor shall become familiar with all details of the work and verify all relevant dimensions in the field.

1.4 DELIVERY AND STORAGE

A. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

PART 2 - PRODUCTS

2.1 TABLE OVER BED (OBO COMPONENT CODE MD001)

A. Description:

1. Overbed table with low profile, U-shaped base, and approximately 475 mm x 800 mm top surface, without vanity.
2. Dimensions: Approximately 800 mm wide x 550 mm deep x 1100 mm high (in raised position).
3. Table height shall be adjustable and provide automatic adjustment as bed/stretcher is raised.
4. Provide hidden casters with polystyrene covers.
5. Provide Dura-Edge to protect table and contain spills.

B. Finish: Colors to be approved by Project Director/COR, in coordination with A/E of Record documentation and with OBO SME input, from manufacturer's standard colors.

C. Basis of Design: Stryker Medical, model 3150-000-001, single top without vanity.

D. NOTE – This equipment would only be required in rare circumstances for a facility that anticipates multi-day hospitalization services such as in high threat/high risk locations.

2.2 EXAMINATION TABLE (OBO COMPONENT CODE MD002)

A. Description: Ergonomically designed manual back examination table equipped with extendable footrest, heated drawer, footstep, paper roll holder, and stainless steel treatment pan.

B. Electrical: Single point of connection. Coordinate plug type and project electrical.

C. Finish: Color to be approved by Project Director/COR, in coordination with A/E of Record documentation and with OBO SME input, from manufacturer's standard colors.

D. Basis of Design: Midmark/Ritter, model 204 Manual Examination Table.

2.3 REFRIGERATOR/FREEZER/ICE MACHINE

A. Pharmaceutical or Lab Refrigerator (OBO Component Code MD004)

1. General: 376-liter (13.3-cf) capacity – Full size
2. Basis of Design: Helmer iPR113-GX

B. Pharmaceutical or Lab Refrigerator (OBO Component Code)

1. General: 150-liter (5.3-cf) capacity - Undercounter
2. Basis of Design: Helmer iPR105-GX

C. Pharmaceutical or Lab Freezer (OBO Component Code)

1. General: 572-liter (20.2-cf) capacity – Full size
2. Basis of Design: Helmer iLF120-GX

D. Pharmaceutical or Lab Freezer (OBO Component Code _____)

1. General: 150-liter (5.3-cf) capacity - Undercounter
2. Basis of Design: Helmer iLF105-GX

E. Full-Size Refrigerator/Freezer (for staff/breakroom use only) (OBO Component Code MD037):

1. General: 510-liter (18-cf) capacity
2. Basis of Design: Summit Model BKRF18W

2.4 ULTRA-LOW FREEZER, (OBO COMPONENT CODE MD038)

A. Description: Ultra-low freezer for storing vaccines with the following features:

1. General: Full size; 370-liter (13-cf) capacity. Undercounter: 54- liter (2 cf) capacity.
2. Temperature Range: -40 dec C to -85 deg C.
3. Controls: Digital datalogging, battery back-up, hi/low alarm

B. Basis of Design: Full Size: So-low model U85-13.UNDERCOUNTER So-Lo model MV85-2

2.5 CART, PROC (OBO COMPONENT CODE MD006)

A. Description: General Procedure Cart with the following features:

1. Aluminum push handle with stainless steel top.
2. Powder-coated steel body; red.
3. Two-drawers; two locking doors

4. Wrap-around vinyl bumper.
5. Removable plastic top.
6. Full extension drawer slides.
7. Heavy-duty casters.

B. Basis of Design: Harloff Cart, model 6200 Standard

2.6 [LABORATORY BIOLOGICAL SAFETY CABINET (BSC) HOOD (OBO COMPONENT CODE MD020)

A. Description: A small biosafety cabinet that can be used into any laboratory space due to it's small footprint. conforming to the following:

1. Airflow: 70% air re-circulation, 30% air exhaust with sash
2. D.
3. Plumbing: None required.
4. Controls: Provide with display and power supply (face velocity sensor).
5. HVAC: Fan shall run continuously during occupied hours.
6. HEPA filter: 99.99% efficiency at 0.3µm

B. Electrical:

1. Fabricate one 20-amp GFI outlet on front exterior face of hood.
2. Hood shall be fabricated with LED light.
3. Fabricate light switch on front exterior face of hood.
4. UV Lamp 15W

C. Lights and outlet shall be pre-wired by hood manufacturer Basis of Design: Pro-Safe Class II (A2) Biosafety Cabinet PLS150

1. Alarm with Digital Meter Display: .
2. One ground fault interrupter outlet on hood:

2.7 SPECIMEN PASS THRU (OBO COMPONENT CODE MD026)

A. Description: Recessed Specimen Pass-Thru Cabinet. Type 304 stainless steel, satin finish. Self-closing doors. Interlocking mechanism prevents both doors from being open at the same time; provides sight barrier. Removable stainless steel tray.

B. Basis of Design: Bobrick model B-505.

2.8 PROCEDURE STRETCHER, OB/GYN (OBO COMPONENT CODE MD027)

A. Description: Lightweight manual ambulance cot with height adjustment, release handle design, dampened action during hot drops, fold-down side rails, wheel lock.

B. Finish: Manufacturer's standard colors.

C. Basis of Design: Stryker, model MX-PRO R3.

2.9 CHAIRS AND STOOLS

A. Chair, Blood Draw with Drawer (OBO Component Code MD032)

1. Description: Upholstered blood-drawings chair, with the following features:

a. Adjustable pivot armrest.
b. Upholstered seat & back.
c. Weight capacity of 450 lbs.
d. Storage cabinet.

2. Basis of Design: Winco, model Unity BDC #2574.

B. Exam Stool (OBO Component Code FN110)

1. Description: Pneumatic physician's stool with heavy-gage vinyl cover and foam padding, with the following features:

a. Seat height adjustable from 457 mm to 622 mm.
b. Backless.
c. 5-star base for stability.
d. 82 mm thick high-density foam.

2. Basis of Design: Midmark/Ritter, model 272 Air Lift.

C. Finish: Colors to be approved by Project Director/COR, in coordination with A/E of Record documentation and with OBO SME input, from manufacturer's standard colors.

2.10 RECEPTACLE WASTE, SHARPS COLLECTION (OBO COMPONENT CODE MD033)

A. Description: Container and wall-mounted bracket for attachment.

1. Capacity: 11-liters
2. Color: Red with appropriate markings and warnings stenciled on container.

B. Basis of Design: Harloff, model ML 684802.

2.11 DISPENSER GLOVE BOX (OBO COMPONENT CODE MD034)

A. Description: Wall-mounted dispenser with capacity for three boxes of disposable gloves.

B. Basis of Design: MarketLab, Inc., model ML 1052, white epoxy.

2.12 CABINET, DEFIBRILLATOR / AUTO-INJECTOR, RECESSED

A. Description: Tall AED Wall Cabinet with adjustable shelf and Alarm. Recessed wall installation.

1. Capacity: Combined AED Storage and Auto-Injector Storage.
2. Color: Coordinate selection with interior finishes and/or fire extinguisher cabinets. Provide appropriate markings stenciled on cabinet.

B. Basis of Design: AED Brands model TWR-A.

1. CABINET, DEFIBRILLATOR / AUTO-INJECTOR, SEMI-RECESSED

C. Description: Tall AED Wall Cabinet with adjustable shelf and Alarm. Semi-recessed wall installation.

1. Capacity: Combined AED Storage and Auto-Injector Storage.
2. Color: Coordinate selection with interior finishes and/or fire extinguisher cabinets. Provide appropriate markings stenciled on cabinet.

D. Basis of Design: AED Brands model TWSR-A.

2.13 MAYO STAND

A. Description: Instrument stand with steel based and removable tray.

1. Stable, heavy 23” diameter base design with 5-leg, all stainless steel construction.
2. Easy positioning with no need to tip style base.
3. Adjustable height range of 33” (838mm) to 49” (1245mm) high.
4. Removable stainless steel tray, minimum 19”x12.75”x0.75” (483mm x 324mm x 19mm)
5. 4 Easy-roll casters with 4 ball hearings
6. Knob lock height adjustment
7. 15lbs. load capacity under normal use.
8. 5-year limited warranty.

B. Basis of Design: Medicus Health, SKU#: 2721M1

2.14 SURGICAL LIGHT

A. Description: Ceiling mounted LED surgical light.

1. Illuminance: 45,000 lux at 1 meter
2. Color Temperature: 4300 Kelvin
3. Color Rendering Index: 92
4. Diameter of Lighthead: 51cm (20”)
5. Focusing: Adjustable using center handle
6. Light Source: Light Emitting Diodes (LED)
7. Number of LED Modules: 3
8. Swivel Radius of Lamp Housing: 160 cm (63”) maximum
9. Total Weight: 45 lbs (20.4 kg)
10. 5-year limited warranty.

B. Basis of Design: AIM LED Light Ceiling Mount, 7110037 Burton Medical LLC ALEDSC00

PART 3 - EXECUTION

3.1 CONDITION OF SUBSTRATES

A. Examine the substrates, adjoining construction and conditions under which the Work is to be installed. Do not proceed with the Work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.

3.2 PREPARATION

A. Verify dimensions of supporting structure by field measurements so that equipment work will be accurately designed, fabricated and fitted to the structure. Examine roughed-in mechanical and electrical services, installation of floors, walls, columns, and ceilings, and other conditions under which medical equipment work is to be installed. Notify Contractor in writing, of any dimensions found to be different than shown. Use Contractor's benchmarks as basis of measurements.

3.3 INSTALLATION, GENERAL

A. Coordinate equipment work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work. Furnish installation templates, diagrams, and other data to fabricators and installers of related work as necessary for coordination of the installation. Place such items, including pipes, conduit, inserts and anchors, accurately in relation to the final location of equipment components.

B. Install all components of the equipment in accordance with the manufacturer's written instructions and recommendations.

C. Verify plumbing, ventilation and electrical connection requirements for all equipment with manufacturer and coordinate connections with Division 22, 23, and 26 work.

D. Each AED cabinet shall display emergency phone number and procedures for notification of an emergency for the facility or local EMS. Signage and instructions shall be in English and in the official language of the host nation.

E. Install AED cabinets in compliance with the Architectural Barriers Act guidelines for AEDs in public areas.

F. AED Cabinets shall be installed in locations as follows:

1. In close proximity to Post 1 in the general work area.
2. Exercise rooms/gyms and at Recreation Buildings/Cabanas.
3. Outside electrical and telecom rooms.
4. Outside the entrance into the Health Unit.
5. Near elevators or stairwells.
6. Representational spaces, including but not limited to Main Lobby, Consular Waiting Rooms, American Centers, Gallery, Cafeteria, Chief of Mission Residences.
7. RSO Office Suite.
8. Inside each Compound Access Control building within close proximity to the guard booth.

3.4 CLEANING

A. Install medical equipment when there is no longer danger of damage to from other construction work. Remove all protective coverings and packing material, and leave units in clean condition internally and externally, ready for operation. Restore exposed and semi-exposed finishes to remove abrasions and other damage; touch-up painted surfaces. Remove and replace damaged products that cannot be successfully restored.

B. Final Cleaning: After testing and start-up, and before time of Substantial Completion, clean and sanitize medical equipment, and leave in condition ready for use in medical service.

END OF SECTION 117000

SECTION 118126 – FACADE MAINTENANCE AND FALL PROTECTION ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes systems and components to facilitate façade maintenance where required due to building height or grade conditions. Façade maintenance fall protection systems shall include fall arrest anchors.

1. [Suspended Scaffold: Provide suspended scaffold with associated davits for window washing and façade maintenance.]
2. [Monorails with Motorized Trolleys: Provide monorail systems with associated motorized trolleys and integrated hoists for interior locations.]
3. [Horizontal Lifelines: Provide horizontal lifelines and accessories for locations requiring access without parapets (i.e., canopies)]
4. [Other systems and equipment based on operations and maintenance and façade strategies in coordination with ODR10.]

B. Related Sections:

1. Section 033000 “Cast-in-Place Concrete.”
2. [Section 075558 “Fluid-Applied Protected Membrane Roofing.”]
3. [Division 07 roofing section.]
4. Division 07 Section on joint sealants.

1.2 SYSTEM DESCRIPTION

A. Fall Arrest Anchor Design Requirements:

1. Safety anchor design shall comply with ANSI/IWCA I-14.1, “Window Cleaning Safety” and OSHA 1910.66, Appendix C, “Personal Fall Arrest.”
2. Structural design requirements:

   a. Anchorage shall be capable of sustaining minimum ultimate load of 2,200 kg (5,000 lbs) in any direction load may be applied, without fracture or failure.
   b. Anchorage shall be capable of sustaining minimum proof load of 1,100 kg (2,500 lbs) in any direction load may be applied, without permanent deformation or damage to anchorage.
   c. Anchorage shall be designed with minimum 550 kg (1,250 lbs) in any direction load may be applied.

3. Each anchor shall be placed in line with work areas serviced by the respective anchor.
4. Anchors shall be placed to allow for two workers to make descents from rope descending system in same work area of the facade for both suspension line and fall arrest line.
5. [Provide fall arrest anchors in parapets in locations identified on Drawings.]

6. Space fall arrest anchors to allow maximum angle of 15 degrees from perpendicular and maximum spacing of 3.5 meters (12 ft.).

B. [Suspended Scaffold System:

1. Scaffolds: Xxx.
2. Associated Davits: Xxx.]

C. [Monorail System:

1. Monorail: Xxx.
2. Motorized Trolley: Xxx.
3. Motorized Hoist: Xxx.]

D. [Horizontal Lifeline System:]

1.3 SUBMITTALS

A. Product Data: General product data.

B. Shop Drawings:

1. Fall Arrest Anchors:

a. Location plan.
b. Detailed plan and section showing typical anchor installation at parapet.

2. [Suspended Scaffold System: Include associated davits. XXX.]
3. [Monorails with Motorized Trolleys: Include associated equipment. XXX.]
4. [Horizontal Lifeline System: Include associated components. XXX.]

C. Laminated Anchorage Drawings: Provide two A3 sheet (11x 17 inch) plastic laminated drawings showing all anchor locations to Project Director/COR. One copy will be for placing on interior of roof level door by Project Director/COR. The other copy will kept with hardcopy O&M Data to serve as replacement drawing.

D. Installation Instructions: Manufacturer's instructions for each type of system. Include guidance on field testing each system.

E. Field Inspection Report: Include completed inspection logbook for inspection of anchorage for each system in accordance with Article on FIELD QUALITY CONTROL.

1. Include anchor layout plan on A3 sheets (11x17 inch) or larger drawing.

F. Field Test Reports: For each type of system.

G. Certification: Letter of certification by registered U.S. Professional Engineer verifying that installed anchorages are in compliance with OSHA regulations and ANSI/IWCA standards referenced in Article on SYSTEM DESCRIPTION.

1. Fall Arrest Anchors:.
2. [Suspended Scaffold: XXX.]
3. [Monorail with Motorized Trolley: XXX.]
4. [Horizontal Lifelines: XXX.]

H. O&M Manual: Provide written operation and maintenance instructions, including ongoing inspection managed by post maintenance personnel, and use of fall protection equipment.

I. O&M Logbook:

1. Provide safety inspection logbook for use in yearly inspections managed by post maintenance personnel. Include instructions on verifying compliance with OSHA regulations and ANSI/IWCA standards referenced in Article on SYSTEM DESCRIPTION.

1.4 QUALITY ASSURANCE

A. Manufacturer:

1. Provide products from company specializing in design, fabrication, and installation of permanent window washing equipment with a minimum of five years of documented experience.
2. Engineering Responsibility: Preparation of engineering analysis and Shop Drawings by a U.S. Professional Engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Installer: Trained or approved by manufacturer in installation techniques and procedures, with minimum five years of documented experience installing permanent window washing equipment.

C. Inspector: Registered U.S. Professional Engineer with experience on suspended maintenance equipment.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original unopened packaging.

B. Storage and Protection:

1. Store materials in area protected from construction activities, and protected from materials and chemicals that are not compatible with anchors.
2. Before installing, clean bolts that have become dirty.

1.6 SEQUENCING AND COORDINATION

A. Contractor is responsible for coordinating submittal process, fabrication, and delivery with construction of building elements receiving anchors.

B. Coordinate anchor installation with parapet construction and coating.

1.7 MAINTENANCE SERVICE PROPOSAL

A. Commencing at the contract's Substantial Completion date for a period of one calendar year with a renewable option for an additional year, provide proposal for system maintenance service based on manufacturer's recommended daily, weekly, quarterly, semi-annual, and annual maintenance activities. The proposal shall be submitted to the COR/Project Director at least 120 days prior to Substantial Completion

B. The proposal shall be inclusive of annual façade cleaning and inspection, as well as the elements identified in the Facade Maintenance Strategy Report in compliance with industry standards and load testing.

C. Maintenance service shall include preventive maintenance, repair or replacement of worn or defective components, required supply of cleaning solutions, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks shall also align with the manufacturer's recommended checklists as required in Division 01 Section 017825 "Systems Manual and O&M Data." Provide completed maintenance records inclusive of scheduling to the USG for inclusion in the CMMS.

PART 2 - PRODUCTS

2.1 FALL ARREST ANCHORS

A. Structural Component Materials

1. Exposed Structural Components:

a. Steel: ASTM A572, GR 50.
b. Steel: ASTM A36.
c. Galvanizing: ASTM A123.
d. Stainless Steel: 304 ASTM A 193 Grade B8, Class 2.

2. Plates: High strength steel, 35 kg/sq. mm (50 ksi) minimum.
3. Nuts and Washers:

a. Stainless Steel: 304 in accordance with ASTM A 193 B8 or F593C.
b. Galvanized Flat Washers: ASTM F-436 or 18-8 stainless steel.

4. Anchors:

a. Stainless Steel: 304 in accordance with ASTM A 193 Grade 8, B8.
b. Size: 16 mm (5/8 inch) diameter minimum.

B. Manufactured Units

1. Anchor:

a. Anchor eye size: 20 mm (3/4 inch) diameter with 60 mm (2-1/4 inch) eye opening minimum.
b. Basis of Design: Summit Anchor Company, Inc. Model SM-81-8-1 anchor/plate with SM-TRA-ADH-7 bolt assembly.

C. Fabrication

1. Fabricate work to dimension, and free from defects detrimental to performance.
2. Grind off surplus welding material to ensure exposed surfaces are smooth to prevent to worker's ropes.
3. Welding: AWS D1.1/D1, "Structural Welding Code."

2.2 [SUSPENDED SCAFFOLDS

A. Scaffold: Xxx

B. Davits: Xxx.]

2.3 [MONORAIL WITH MOTORIZED TROLLEY:

A. Monorail: Xxx.

B. Motorized Trolley: Xxx.

C. Motorized Hoist: Xxx.]

2.4 HORIZONTAL LIFELINE SYSTEM:

A. Cables: Xxx.

B. Anchors: Xxx.]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine construction in which all components will be installed with Installer present.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fall Arrest Anchors:

1. Install anchors in accordance with manufacturer's instructions. Install anchors tightly fitted and flush to adjacent construction.
2. When components come into contact with dissimilar metals, prevent surfaces from direct contact.
3. Deform a minimum of two threads of tail end of anchor studs after nuts have been tightened to prevent accidental removal. Deform threads with 2 mm (2/32 inch) stainless steel punch.

B. [Suspended Scaffold:

1. Associated Davits: Xxx.
2. Scaffold Equipment: Xxx.]

C. [Monorail with Motorized Trolley:

1. Monorail: Xxx.
2. Motorized Trolley: Xxx.
3. Motorized Hoist: Xxx.]

D. Horizontal Lifeline System:

1. Cables: Xxx.
2. Anchors: Xxx.]

3.3 FIELD QUALITY CONTROL

A. Fall Arrest Anchors:

1. Inspection and Site Visits:

a. Perform inspections and site visits while installation of anchors is in progress under supervision of qualified Professional Engineer.
b. Perform on-site inspection on cast items while being tied in with rebar with sufficient time before concrete is poured to allow adjustments to embedded items.
c. Contractor is responsible to schedule site visits and inspections with sufficient advanced notice to Inspector.

2. Field Tests:

a. Test on site in accordance with manufacturer's recommendations and ANSI/IWCA I-14.1, "Window Cleaning Safety Standards" before anchors are placed in service.
b. Test under supervision of qualified Professional Engineer.

c. Inspection Logbook: Complete inspection logbook to certify system for use, noting any deviations, changes, or corrections from shop drawings.

B. [Suspended Scaffold Systems:

1. Inspection and Site Visits: XXX
2. Field Tests: XXX]

C. [Monorail with Motorized Trolley:

1. Inspection and Site Visits: XXX
2. Field Tests: XXX]

D. [Horizontal Lifelines:

1. Inspection and Site Visits: XXX
2. Field Tests: XXX]

3.4 DEMONSTRATION

A. Manufacturer's service representatives shall train Government personnel to operate the equipment and adjust and test anchorage. Review "O&M Manual" and "O&M Logbook" submittals; see Article on SUBMITTALS. Refer to Division 01 Section "Demonstration and Training."

1. Schedule as follows:

a. Classroom Instruction: Four (4) hours.
b. Field Demonstration: Four (4) hours.

END OF SECTION 118126

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated roller shades.
2. Motor-operated roller shades.

B. Material Index / Material Codes Include:

1. WSG-[##] <(MANUALLY OPERATED) ROLLER WINDOW SHADES.>
2. WSG-[##] <(MOTOR-OPERATED) ROLLER WINDOW SHADES.>
3. FBG-[##] <FABRIC.>

C. Related Requirements:

1. Division 06 Section on "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
2. Division 07 Section on "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.
3. **[Division 12 Section on “Horizontal Louver Blinds.”]**
4. **[Division 12 Section on “Drapes.”**]
5. Division 26 Sections for associated general electrical work.
6. Division 26 Section on “Lighting Control Devices” for coordinated control of window shades at Consular Waiting Area.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 USE OF MOTORIZED MECHANISMS

A. Motorized Shade Mechanisms:

1. Sensor-controlled motors are not permitted in CAA areas.
2. In CAA, use of motors is governed by restrictions in Chapter 1 of the OBO Electrical Code. Motors shall be incapable of Wi-Fi, Bluetooth, or near-field communication.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Manually Operated Shades:

a. Show location and extent of roller shades.
b. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
c. Include reflected ceiling plans showing ceiling suspension system members and attachment to building structure.

2. Motor-Operated Shades:

a. Show location and extent of roller shades.
b. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
c. Include reflected ceiling plans showing ceiling suspension system members and attachment to building structure.
d. Show size and location of access to shade operator, motor, and adjustable components.
e. Show locations and details for installing operator components, switches, and controls.

1) Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
2) In relation to the Consular Waiting Area show interface of lighting controls, located in the staff side of the Consular Section, with window shades at exterior walls of the Consular Waiting Area. Refer to Division 26 Section on “Lighting Control Devices.”

f. Include wiring diagrams showing power, system, and control wiring.

3. Include field-measured dimensions of each opening to receive shades.
4. Number each shade on Shop Drawing to correspond to identification number given each shade and applied on an unexposed face of shade unit.

C. Samples for Verification: For each type of roller shade.

1. Shadeband Material: Not less than [**250 mm**] square. Mark interior face of material if applicable.
2. Roller Shade: Full-size operating unit, not less than 400 mm wide by 900 mm long for each type of roller shade indicated.
3. Installation Accessories: Full-size unit, not less than 250 mm long.

D. Glare Analysis at Consular Waiting Area:

1. At consular window where officer and applicant interact, the applicant backdrop commonly has exterior glazing. Background luminance can make it challenging for officer to clearly see applicant's face. Light-filtering fabric that appropriately supports an environment with imperceptible glare is required.
2. Utilizing 3D geometry and shade performance data (reflectance, transmission, and openness factor), perform Daylight Glare Probability (DGP) analysis to confirm DGP rating of 0.35 or less as viewed from position of officer.
3. Analysis shall be undertaken with clear sky condition at time of day and year where sun's incident angle is most aligned with surface normal of glazing.
4. Submit analysis with shop drawings for approval.

E. Product Schedule: For roller shades.**[Use same designations indicated on Drawings.]**

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer.
2. For Trainer.

B. Product Certificates: For each type of shadeband material.

C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Include the following:

a. Methods for maintaining roller shades and finishes.
b. Precautions about cleaning materials and methods that could be detrimental to shadecloth, finishes, and performance.
c. Operating hardware.
d. Motorized shade operator.

2. Include copy of submittal in Project information manual.

B. Warranties: Submit signed and dated warranties.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Furnish minimum of five sets of the following for each type and size of shading system.

1. Fabric Material: Pre-cut solar shade and blackout panels sized to match each type of installation (to facilitate replacement).
2. Hardware: All hardware, brackets, anchors, fasteners, and accessories necessary for complete, finished installation.
3. Motor Kit: Replacement motor kits for each type of motorized system installed.
4. Repair Kit: Manufacturer's recommended kits for each type of installed shade (solar and blackout).

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain shades for windows through one source from a single manufacturer.

B. Installer Qualifications: Fabricator of products.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Approval of mockups sample installations does not constitute approval of deviations from the Contract Documents contained in sample installations unless Project Director/COR, based on input from the A/E of Record, specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Training Instructor: At least five years' experience in installation and operation of installed system.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings.

B. Store in protected and dry area in manufacturer's unopened protective shipping packaging.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Project Director/COR of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS **[WSG-[##]]**:

A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: **[Manufacturer's standard] [Nickel-plated metal] [Stainless steel] [Plastic] <Insert description>**.

a. Loop Length: **[Full length of roller shade] [As indicated on Drawings] <Insert length>**.
b. Limit Stops: Provide upper and lower ball stops.
c. Chain-Retainer Type: **[Clip, jamb mount] [Chain tensioner, jamb mounted] [Chain tensioner, sill mounted] <Insert description>**.

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

a. Provide for shadebands that weigh more than [**4.5 kg**] <**Insert value**> or for shades as recommended by manufacturer, whichever criterion is more stringent.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: [Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>.

2. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.
3. Shadeband-to-Roller Attachment: **[Manufacturer's standard method] [Adhesive strip] [Removable spline fitting into integral channel in tube] <Insert description>**.

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

E. Shadebands:

1. Shadeband Material: **[Light-filtering fabric] [Light-blocking fabric] <Insert requirements>**.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: **[Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] [Exposed with endcaps and integral light seal at bottom where it meets the sill] <Insert description>**.

b. Color and Finish: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and finish>**.

F. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.

a. Shape: **[L-shaped] [Curved] <Insert requirements>**.
b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] <Insert dimension>**.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] [height indicated on Drawings] <Insert dimension>**.

3. Endcap Covers: To cover exposed endcaps.

4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[150 mm] [125 mm] [100 mm] [height indicated on Drawings] <Insert dimension>**.
b. Provide pocket with lip at lower edge to support acoustical ceiling panel.

5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

a. Closure-Panel Width: **[As indicated on Drawings] [50 mm] <Insert dimension>**.

6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops. Side channels are required at every black-out shade location unless otherwise noted.

7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed. Sill channels are required at every black-out shade location unless otherwise noted.
8. Installation Accessories Color and Finish: [As selected from manufacturer's full range] <Insert color and finish>.

2.2 MANUALLY OPERATED SHADES WITH DOUBLE ROLLERS **[WSG-[##]]**:

A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: **[Manufacturer's standard] [Nickel-plated metal] [Stainless steel] [Plastic] <Insert description>**.

a. Loop Length: **[Full length of roller shade] [As indicated on Drawings] <Insert length>**.
b. Limit Stops: Provide upper and lower ball stops.
c. Chain-Retainer Type: **[Clip, jamb mount] [Chain tensioner, jamb mounted] [Chain tensioner, sill mounted] <Insert description>**.

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

a. Provide for shadebands that weigh more than **[4.5 kg] <Insert value>** or for shades as recommended by manufacturer, whichever criterion is more stringent.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Double-Roller Mounting Configuration: **[Side by side] [Offset, outside roller over and inside roller under] <Insert requirements>**.
2. Inside Roller:

a. Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.

b. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.

3. Outside Roller:

   a. Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.

   b. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.

4. Shadeband-to-Roller Attachment: **[Manufacturer's standard method] [Adhesive strip] [Removable spline fitting into integral channel in tube] <Insert description>**.

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

E. Inside Shadebands:

1. Shadeband Material: Light-filtering fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

   a. Type: **[Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] <Insert description>**.

   b. Color and Finish: **[As selected by Project Director/COR from manufacturer's full range] <Insert color and finish>**.

F. Outside Shadebands:

1. Shadeband Material: Light-blocking fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

   a. Type: **[Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] [Exposed with endcaps and integral light seal at bottom where it meets the sill] <Insert description>**.

   b. Color and Finish: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and finish>**.

G. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.

   a. Shape: **[L-shaped] [Curved] <Insert requirements>**.

b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] <Insert dimension>**.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

   a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] [height indicated on Drawings] <Insert dimension>**.

3. Endcap Covers: To cover exposed endcaps.

4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

   a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[150 mm] [125 mm] [100 mm] [height indicated on Drawings] <Insert dimension>**.
   b. Provide pocket with lip at lower edge to support acoustical ceiling panel.

5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

   a. Closure-Panel Width: **[As indicated on Drawings] [50 mm] <Insert dimension>**.

6. [Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops. Side channels are required at every black-out shade location unless otherwise noted.]

7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed. Sill channels are required at every black-out shade location unless otherwise noted.
8. Installation Accessories Color and Finish: **[As selected from manufacturer's full range] <Insert color and finish>**.

2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES **[WSG-[##]]**:

A. Motorized shades are required in Consular applicant waiting area at exterior glazing.

B. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation

without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Electric Motor: [**Manufacturer's standard**] <**Insert description**> tubular, enclosed in roller.

   a. Electrical Characteristics: **[As indicated on Drawings] <Insert requirements>**.
   b. Maximum Total Shade Width: **[As required to operate roller shades indicated] <Insert requirements>**.
   c. Maximum Shade Drop: **[As required to operate roller shades indicated] <Insert requirements>**.
   d. Maximum Weight Capacity: **[As required to operate roller shades indicated] <Insert requirements>**.

3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure. Provide the following for remote-control activation of shades where scheduled or indicated on Drawings:

   a. Group Control Station: **[Maintained] [Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
   b. Consular Waiting Area: See Division 26 Section on “Lighting Control Devices” for control of motorized shade. Provide override function to control shades on exterior wall of that area.
   c. [Sun Sensor Control: Adjustable system consisting of digital displays detecting sun intensity and responding by automatically adjusting shades.]
   d. [Timer Control: Clock timer, [24-hour] [seven-day] <Insert period> programmable for regular events.]

   e. Color: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
5. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
6. Operating Features:

   a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
   b. Capable of accepting input from building automation control system.

   c. Override switch.

7. Accessories:

a. **<Insert accessory>**.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.

2. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.
3. Shadeband-to-Roller Attachment: **[Manufacturer's standard method] [Adhesive strip] [Removable spline fitting into integral channel in tube] <Insert description>**.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.

F. Shadebands:

1. Shadeband Material: **[Light-filtering fabric] [Light-blocking fabric] <Insert requirements>**.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: **[Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] [Exposed with endcaps and integral light seal at bottom where it meets the sill] <Insert description>**.

b. Color and Finish: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and finish>**.

G. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.

a. Shape: **[L-shaped] [Curved] <Insert requirements>**.
b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] <Insert dimension>**.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

a. Height: Manufacturer's standard in height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] [as indicated on Drawings] <Insert dimension>**.

3. Endcap Covers: To cover exposed endcaps.

4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

   a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[150 mm] [125 mm] [100 mm] [height indicated on Drawings] <Insert dimension>**.
   b. Provide pocket with lip at lower edge to support acoustical ceiling panel.

5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

   a. Closure-Panel Width: **[As indicated on Drawings] [50 mm] <Insert dimension>**.

6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops. Side channels are required at every black-out shade location unless otherwise noted.

7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed. Sill channels are required at every black-out shade location unless otherwise noted.
8. Installation Accessories Color and Finish: [As selected from manufacturer's full range] <Insert color and finish>.

2.4 MOTOR-OPERATED, DOUBLE-ROLLER SHADES **[WSG-[##]]**:

A. Motorized Operating Systems: Provide factory-assembled, shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

   1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   2. Electric Motor: **[Manufacturer's standard] <Insert description>** tubular, enclosed in rollers.

a. Electrical Characteristics: **[As indicated on Drawings] <Insert requirements>**.
b. Maximum Total Shade Width: **[As required to operate roller shades indicated] <Insert requirements>**.
c. Maximum Shade Drop: **[As required to operate roller shades indicated] <Insert requirements>**.
d. Maximum Weight Capacity: **[As required to operate roller shades indicated] <Insert requirements>**.

3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure. Provide the following for remote-control activation of shades where scheduled or indicated on Drawings:

a. Group Control Station: **[Maintained] [Momentary]**-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
b. [Sun Sensor Control: Adjustable system consisting of digital displays detecting sun intensity and responding by automatically adjusting shades.]
c. [Timer Control: Clock timer, [24-hour] [seven-day] <Insert period> programmable for regular events.]

d. Color: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
5. Limit Switches: Adjustable switches, interlocked with motor controls and set to stop shade movement automatically at fully raised and fully lowered positions.
6. Operating Features:

a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
b. [Capable of accepting input from building automation control system.]

c. Override switch.

7. Accessories:

a. **<Insert accessory>**.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shades for service.

1. Double-Roller Mounting Configuration: **[Side by side] [Offset, outside shade over and inside shade under] <Insert requirements>**.
2. Inside Roller:

a. Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.

b. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.

3. Outside Roller:

a. Drive-End Location: **[Right side of interior face of shade] [Left side of interior face of shade] [As indicated on Drawings] <Insert requirements>**.

b. Direction of Shadeband Roll: **[Regular, from back (exterior face) of roller] [Reverse, from front (interior face) of roller]**.

4. Shadeband-to-Roller Attachment: **[Manufacturer's standard method] [Adhesive strip] [Removable spline fitting into integral channel in tube] <Insert description>**.

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller mounting configuration, roller assemblies, operating mechanisms, installation accessories, and installation locations and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

E. Inside Shadebands:

1. Shadeband Material: Light-filtering fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: **[Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] <Insert description>**.

b. Color and Finish: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and finish>**.

F. Outside Shadebands:

1. Shadeband Material: Light-blocking fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: **[Enclosed in sealed pocket of shadeband material] [Exposed with endcaps] [Exposed with endcaps and integral light seal where bottom (sill) channels are indicated] <Insert description>**.

b. Color and Finish: **[As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color and finish>**.

G. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.

    a. Shape: **[L-shaped] [Curved] <Insert requirements>**.
    b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] <Insert dimension>**.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

    a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[100 mm] [75 mm] [as indicated on Drawings] <Insert dimension>**.

3. Endcap Covers: To cover exposed endcaps.

4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

    a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than **[150 mm] [125 mm] [100 mm] [height indicated on Drawings] <Insert dimension>**.
    b. Provide pocket with lip at lower edge to support acoustical ceiling panel.

5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recesses or pockets and for snap-in attachment to wall clip without fasteners.

    a. Closure-Panel Width: **[As indicated on Drawings] [50 mm] <Insert dimension>**.

6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops. Side channels are required at every black-out shade location unless otherwise noted.

7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed. Sill channels are required at every black-out shade location unless otherwise noted.
8. Installation Accessories Color and Finish: **[As selected from manufacturer's full range] <Insert color and finish>**.

2.5 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant **[FBG-[##]]**:

1. Source: **[Roller shade manufacturer] <Insert source for custom fabrics>**.
2. Type: **[PVC-coated fiberglass] [PVC-coated polyester] [Woven PVC-coated fiberglass and PVC-coated polyester] [Woven polyester and PVC-coated polyester] [Acrylic-coated fiberglass] [PVC-coated fiberglass with silver backing] <Insert description>**.
3. Weave: **[Mesh] [Basketweave] <Insert description>**.
4. Thickness: **<Insert thickness>**.
5. Weight: **<Insert g/sq. m>**.**[900 mm] [1200 mm] [1500 mm] [1800 mm] [2100 mm] <Insert dimension>**Orientation on Shadeband: **[Up the bolt] [Railroaded] [As indicated on Drawings] <Insert requirements>**.
8. Openness Factor:

   a. **[1] [3] [5] [10] [11] [22] <Insert number>** percent.
   b. Consular Waiting Area: 1 percent, or as identified by Glare Analysis to facilitate more openness without compromising officer visibility; see Part 1 Article on ACTION SUBMITTALS.

9. Color:

   a. General Usage: **[As indicated on Drawings] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.
   b. Consular Waiting Area: Consular Waiting Area: Black, or lighter color fabric where usage is supported by findings of Glare Analysis; see Part 1 Article on ACTION SUBMITTALS.

C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant **[FBG-[##]]**:

1. Source: **[Roller shade manufacturer] <Insert source for custom fabrics>**.
2. Type: **[Fiberglass textile with PVC film bonded to both sides] [Fiberglass with acrylic backing] [Acrylic-coated fiberglass] [Polyester-cotton blend] [Polyester with foamed-acrylic backing] [PVC-coated fiberglass with bonded PVC film] <Insert description>.**
3. **Thickness: <Insert thickness>**.
4. Weight: **<Insert g/sq. m>**.
5. Roll Width: **[900 mm] [1200 mm] [1500 mm] [1800 mm] [2100 mm] <Insert dimension>**.

6. Orientation on Shadeband: **[Up the bolt] [Railroaded] [As indicated on Drawings] <Insert requirements>**.
7. Features: **[Washable] [Antistatic treatment] <Insert requirements>**.

8. Color: **[As indicated on Drawings] [Match Project Director/COR's sample] [As selected by Project Director/COR, based on input from the A/E of Record, from manufacturer's full range] <Insert color>**.

2.6 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 23 deg C:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 6 mm per side or 13-mm total, plus or minus 3.1 mm. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 6 mm, plus or minus 3.1 mm.

2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than **[1:4] <Insert ratio>**, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

1. Opaque Shadebands: Located so shadeband is not closer than **[50 mm] <Insert dimension>** to interior face of glass. Allow clearances for window operation hardware.

B. Controls for Motorized Shades in Consular Waiting Area:

1. Refer to Division 26 Section on "Lighting Control Devices" for controls serving this area that integrate both lighting and shade operation of the Consular Waiting Area; that referenced Section also identifies location for those controls.
2. Install override control for shade operation adjacent to lighting controls serving this area.

C. Electrical Connections: Connect motor-operated roller shades to building electrical system.

D. Roller Shade Locations: As indicated on Drawings **<Insert requirements>**.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Project Director/COR, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-trained service representative to train Project Director/COR's maintenance personnel to adjust, operate, and maintain motor-operated roller shades. Provide two hours of classroom training, and four hours of demonstration.

B. Training Plan: Develop training materials for this system and its interface with other systems and assemblies. Training materials shall include the following:

1. Wiring Diagrams: As-built diagrams with sizes for all motorized systems, cables, connectors, and equipment. Identify connection points.
2. Activation Controls of Shades: Review sequence of operations of controls for system.
3. Equipment List: Manufacturer's list of system and component parts for each type of shade system (including solar and blackout).

4. Maintenance Procedures: Manufacturer recommended procedures for maintaining and troubleshooting system.

END OF SECTION 122413

SECTION 124816 – ENTRANCE FLOOR GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Recessed floor grilles and frames.

B. Material Index / Material Codes Include:

1. **EMF-[##]** ***<ENTRANCE MAT FLOOR (GRILLE).>***

C. Related Requirements:

1. Division 03 Section on "Cast-in-Place Concrete" for concrete recess to receive grilles.
2. Division 05 Section on metal fabrications for grout.
3. Division 08 door hardware Sections for door control devices.
4. Division 09 Sections for floor finishes which interface with grilles.

1.2 COORDINATION

A. Coordinate size and location of recesses in concrete to receive floor grilles and frames.

B. Coordinate floor grille drain with storm drain system.

1.3 PERFORMANCE

A. Structural Performance: Provide floor grilles and frames capable of withstanding the following loads and stresses:

1. Rolling Load: 500 lb. per wheel, as applied by solid 125-mm x 50-mm polyurethane wheel in 1,000 passes, with no damage.

B. Accessibility Requirements: Comply with accessibility provisions in the Chapter 11 of the OBO Building Code (International Building Code as amended by OBO).

C. Sustainability: Conform to sustainability requirements and selections for the Project.

D. Flammability: ASTM E648, Class I, Critical Radiant Flux minimum 0.45 watts/m2.

E. Slip Resistance: ASTM D-2047, Coefficient of Friction minimum 0.60 at accessible routes.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for entrance grilles.

B. Shop Drawings:

1. Layout of grid and frames. Include direction of travel, divisions between grille sections, spline locations, profiles, anchors, and accessories.
2. Items penetrating floor grilles and frames, including placement of with door control devices.
3. Perimeter floor moldings and interface with adjacent finishes.
4. **[Radiant Snow Melting: Provide schematics, including identifying location of controls.]**

C. Samples: For the following products, in manufacturer's standard sizes:

1. Floor Grille: Minimum 100-mm x 100-mm section for each grille type, including insert.
2. Frame Members: Minimum 100-mm long sample of each frame type and color.

D. Maintenance Data: For floor grilles and frames to include maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site ready for use and fabricated in as large sections and assemblies as practical, in unopened original factory packaging clearly labeled to identify manufacturer and location for installation.

1.6 FIELD CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

1.7 SEQUENCING AND SCHEDULING

A. Delay installation of floor mat frames until after building enclosure is complete and related interior finish work is complete.

B. Recessed Frame: Install floor mat frames concurrently with stone floor system installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide products comparable to the following in accordance with the Schedule:

1. Type I Entrance Grilles: GridLine 2 w/ carpet Insert, C/S Group.
2. [Type II Entrance Grilles: GridLine 2 w/o insert, C/S Group.]
3. [Type III Entrance Grilles: PetiTred LP G3 w/ vinyl insert, C/S Group.]

4. [Type IV Entrance Grilles: Heated PediTred G4 w/ carpet insert, C/S Group.

a. **Radiant Snow Melting: Heatizon Systems.]**

2.2 FLOOR GRILLES **[EMF-[##]]**

A. General: Provide manufacturer's standard floor-grille assemblies consisting of treads of type and profile identified, interlocked or joined together by cross members, and with support legs (if any) and other components needed to produce a complete installation.

B. Stainless-Steel Floor Grille (Type I and II Grilles): Type 304 for surface wires and U-clip support structures.

1. Depth: 19-mm (3/4 inch) or 28-mm (1-1/8 inch), as coordinated with adjacent walkway surface finish.
2. Carpet Receiver Insert: 30 mm (1-1/4 inch) stainless steel. Spacing insert at **[XX mm]**.
3. Lockdown: Manufacturer's standard hidden lockdown mechanism.

C. Aluminum Floor Grille (Type III and IV Grilles):

1. Extruded Aluminum: ASTM B 221M, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52 as standard with manufacturer. Coat surface of frame in contact with cementitious materials with manufacturer's standard protective coating.

D. Tread Inserts:

1. Carpet (Type II and IV Grilles): Carpet conforming to Carpet and Rug Institute's standard for indoor air quality. Fibers shall be minimum 100, 0.3 mm (12 mil) monofilament fibers per 650 sq. mm. (1 square inch), and colorfast solution-dyed nylon. Each carpet fiber and monofilament shall be fusion-bonded to rigid two-ply backing to prevent fraying, and provided in continuous splice-free lengths. Anti-static carpet fiber shall contain antimicrobial additive, and treated to reduce soiling. Carpet weight shall be 1,100 g/sq. m

(33-oz/yd^2). Color as selected by Project Director/COR from manufacturer's standard selections, with minimum of 10 choices.

a. Basis of Design: MonoTuft HD.

2. Vinyl (Type III Grilles).

2.3 FRAMES

A. Provide manufacturer's standard frame of size and style for grille type, for permanent installation in subfloor, complete with installation anchorages and accessories. Fabricate frame of same material and finish as grilles.

1. Type I and II Grilles:

a. Angle frame, 22 mm (7/8 inch) deep recess, Type 304 stainless steel, 3.2 mm (1/8 inch) exposed surface.

2. Type III and IV Grilles:

a. Recessed tapered angle frame, deep recess, ASTM B 221M, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52 as standard with manufacturer.

2.4 FABRICATION

A. Shop fabricate floor grilles to greatest extent possible in sizes as indicated. Unless otherwise indicated, provide each grille as a single unit; do not exceed manufacturer's recommended sizes for units that are removed for maintenance and cleaning. Where joints are necessary, space symmetrically and away from normal traffic lanes.

B. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

2.5 METAL FINISHES

A. Stainless Steel: Satin finish.

B. Aluminum: Clear anodized.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and floor conditions for compliance with requirements for location, size, minimum recess depth, and other conditions affecting installation of floor grilles and frames.

B. Examine roughing-in for drainage piping systems to verify actual locations of piping connections before floor grille and frame and drain pan installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install recessed floor grilles and frames to comply with manufacturer's written instructions at locations indicated, and with top of floor grilles and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer.

1. Set floor-grille tops at height for most effective cleaning action.
2. Coordinate top of floor-grille surfaces with bottom of doors that swing across grilles to provide clearance under door.
3. Finish surface beneath grill with leveling screed.

B. Drainage: For grilles installed outside of buildings, grille units shall facilitate interface with building storm drain system.

1. Install with trench drains rather than sloped drain.
2. Tie drains to building storm sewer system.

C. [Snow Melt Controls:

1. CACs: Place controls in Guard Booth for Main and Service CAC, and at Guard Station for Consular CAC.
2. Consular Waiting: Place controls at Guard Desk.]

3.3 CLEANING

A. Clean mats as recommended by manufacturer.

1. Do not use materials or methods which may damage metal finish, insert surfaces, or surrounding construction.
2. Clean recesses to remove dust and debris before final installation of mat.

3.4 PROTECTION

A. After completing frame installation, provide temporary filler of plywood or fiberboard in floor-grille recesses, and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 124816

SECTION 125005 – GFE FURNITURE INSTALLATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section identifies administrative and execution requirements of "furniture, furnishings, and equipment (FF&E)" installation by Contractor. These items are Government Furnished Equipment; Contractor Installed (GFCI) items. Approximate locations of these items are identified on Construction Drawings, with detailed locations and information provided on Furniture Installation Plans prepared by U.S. Government. GFE furniture items are located in various building types, including the following where indicated on the Drawings:

1. [Office Building: Systems and freestanding FF&E.]
2. [Residential FF&E.]

a. [Marine Security Guard Residence (MSGR).]
b. [Staff housing (SDA).]
c. [Representational residence.]

3. Other building types:

a. [Warehouse.]
b. [American Club.]
c. **[Xxx.]**

B. Related Requirements:

1. Division 26 and Division 27 sections for conduits, wire ways, connection boxes, pull boxes, junction boxes, electrical breaker panels required to power FF&E.

1.2 DEFINITIONS

A. Furniture, Furnishings, and Equipment (FF&E): The term is used by OBO in relation to items that are Government Furnished.

1. Equipment: While FF&E includes the term Equipment which is typically indicated as Other Furnished, Other Installed (OFOI), in this context, the term FF&E is used generically and excludes OFOI.

B. Furniture:

1. **[Systems Furniture: A completely integrated office furniture system, capable of configuration as panel system with panel-mounted components, or as freestanding desk or storage system. Components include power and telecommunications**

distribution, specific to the project, and other components such as associated lighting, computer support accessories, and paper management accessories.]

2. Freestanding Furniture: Non-system furniture; these stand independent of systems furniture in places where they are co-located. Assembly, support, or attachment is required for some freestanding furniture items. Freestanding furniture are used in all building types for which GFE furniture installation is used.

C. Furnishings: Supplemental products such as letter trays, and waste receptacles. Furnishings are used in all building types for which GFE furniture installation is used.

1.3 SUBMITTALS

A. Project Execution Schedule: The Contractor shall include as minimum the following activities in Baseline Project Execution Schedule being submitted under requirements of Division 01 Section "Project Schedule": The schedule shall include:

1. Contractor's review period and date of submission of Contractor's e-Binder Systems Furniture Report.
2. 90 day period when all furniture will be received at Central Receiving/Consolidation Point (CRP) in accordance with Furniture Installation Plan outlined in Article on SUBMITTALS.
3. Contractor's Review of Vendor Order Bill of Materials (BOM).
4. Date of confirmation of 90 day window of furniture delivery.
5. Electrical and telecommunications rough-in work.
6. Furniture installation mock up for review.
7. Furniture installation phasing/sequencing.
8. Pre-shipment Inspection of existing conditions.
9. Delivery of furniture to site.
10. Request for Inspection of completed furniture installation.

B. Confirmation of GFCI FF&E CRP delivery dates: The Contractor shall confirm in writing to Project Director/COR 400 days in advance of delivery of furniture to their CRP. This confirmation will initiate OBO's procurement process for GFCI FF&E and will establish the period when items are to be delivered to Contractor's CRP. This Letter should also include shipping requirements, warehouse delivery requirements and furniture phasing information.

C. Contractor Report on E-binder Office Systems Furniture Configuration: Contractor shall provide report to Project Director/COR in accordance with requirements in Article on COORDINATION.

1. Contractor shall review plans, configurations and bills of materials for coordination with electrical, telecommunication and architectural work and shall verify quantity take-offs in Bill of Materials (BOM). This report shall be prepared by Furniture Installation Manager. Report shall include comments and discrepancies on accuracy and quantity take-offs of layouts and specifications to build each typical and cluster; and identify any coordination issues with electrical, telecommunications, architectural elements of work.

2. Contractor shall provide Report to Project Director/COR via official letter within 14 days of being notified that e-binder has been uploaded in ProjNet. OBO will complete all vendor orders, both systems and freestanding upon completion of the Contractor's review of e-binders.

D. Vendor Purchase Order Report: Contractor shall provide report to Project Director/COR in accordance with Article on COORDINATION.

1. Submit Report to Project Director/COR via official letter within 14 days of receiving Vendor orders, to accommodate delivery of furniture to CRP during 90-day delivery period.

E. Receiving Reports: Contractor shall provide receiving reports to Project Director/COR in accordance with Article on COORDINATION.

F. Pre-Shipment Inspection Report: Contractor shall submit pre-shipment inspection report in accordance with Article on DELIVERY, STORAGE AND HANDLING.

G. Installer Qualifications: Contractor shall submit qualifications for Furniture Installation Manager and installers in accordance with Article on QUALITY ASSURANCE.

1. Contractor shall submit resumes for OBO approval with initial "Bios of Personnel" for Furniture Installation Manager and installers.
2. Contractor shall submit confirmation of personnel security clearance level.

H. Installation Plan: Contractor shall submit to Project Director/COR detailed installation plan for phasing, placement, and assembly of furniture.

1. Contractor shall provide detailed installation plan for phasing (breakdown of floor by floor and zone by zone), placement, and assembly of furniture. Contractor shall provide detailed plan which outlines on-site storage, handling and phasing/sequencing of GFCI FF&E installation, and confirms scope of mock-up that will be constructed. Plan shall identify Furniture Installers, Furniture Installation Manager and their respective qualifications. Plan shall include installation dates which have been coordinated with completion of work of other trades. This plan will be used by OBO to sequence and organize procurement (and subsequent delivery to the Contractor's CRP) of GFCI FF&E. Installation plan must be approved prior to shipment of any GFCI FF&E to site.

I. Coordination Drawings: Contractor shall prepare and submit to Project Director/ COR coordination drawings in accordance with requirements in Article on QUALITY ASSURANCE.

1. Contractor shall verify and provide updated detailed coordination shop drawings, based on Construction Drawing elevations and details in architectural and electrical drawings, for open plan systems furniture typical conditions for both non-CAA and CAA, which illustrate electrical and telecommunications delivery and termination connectivity in systems furniture to building services; and based on selected GFCI systems furniture product. Coordination Drawings must be submitted and approved by OBO prior to rough-in installation of electrical and telecommunications services in building.

J. Contractor shall verify building systems access points with overlay of furniture plans. The contractor is required to coordinate the layout of items above ceilings or in walls adjacent to furniture that need to be accessed for inspection or maintenance (ie; larger junction boxes, VAVs, mechanical filters, FE/BR inspection hatches, LAA inspection hatches, etc.) should all be show not in conflict with furniture below or item in question.

K. Contractor shall provide an Access Point Conflict Report to the Project Director/COR for coordination of relocation with appropriate OBO discipline.

L. Confirmation of Installation Plan: Contractor shall confirm in writing to Project Director/COR prior shipping furniture to Post, and shall confirm that deficiencies or coordination issues identified in Pre-Shipment Inspection Report have been resolved.

M. [Secure Logistics Requirements: Contractor shall submit the following:

1. **Documentation associated with security clearances for Installers and Installer Manager in accordance with Division 01 Section "Construction Security," and documentation associated with General Shipping Plan and Individual Shipping Plans in accordance with Division 01 section "Secure Shipment."]**

N. Notification of Request for Inspection of Installed Furniture: Contractor shall submit written notice to Project Director/COR that GFCI FF&E furniture is installed, is ready for final inspection and requests date for inspection of completed work 60 days prior to DS Final Accreditation.

O. Record Documents: Contractor shall submit record set of as-installed documents in accordance with requirements of Division 01 Section "Project Closeout". Documents must include:

1. Drawings of actual installation to include any deviations from final OBO Furniture Installation Drawings.
2. Digitized photographs of any damaged material or irregularities.
3. Inventory of any excess material turned over at the completion of installation.

P. Operations and Maintenance Data: Contractor shall collect and organize user maintenance information and materials which are provided by furniture vendors and which are supplied with GFCI FF&E. These materials shall be organized and submitted in time frame in accordance with requirements in Division 01 Section "Project Closeout" record documents. This includes the following:

1. All brochures, tags and other literature enclosed in the protective wrappings or attached to the FF&E furnished for this Section.
2. All excess materials remaining at completion of final inspection.

Q. Warranty Information: Contractor shall collect and organize warranty materials of the FFE, which are Government-Furnished; warranty information is initially provided by furniture vendors. These materials shall be organized and submitted in time-frame in accordance with requirements in Division 01 Section "Project Closeout" warranty information.

1.4 QUALITY ASSURANCE - FURNITURE INSTALLATION IMPLEMENTATION MANAGEMENT:

A. Qualifications: Contractor shall utilize Furniture Installation Manager with minimum five years experience in planning and execution of major furniture installation projects overseas (consisting of minimum of 100 systems furniture workstations and freestanding furniture) where comprehensive pack-out of furniture for overseas shipping and phased installation is required, where alternate power supplies are used, where extreme environmental conditions are present if applicable to this project, and where personnel security and secure logistics are required. Furniture Installation Manager shall employ experienced installers trained by systems furniture manufacturers Allsteel, Haworth, and MillerKnoll. Qualified Furniture Installation team must remain on site for the full duration of the GFE Furniture Installation period.

B. Mock-Up Installation: Mock-up workstation, conference credenza, conference table, and consular window furnishings to be identified during Installation Planning Phase. Prepare mock-up installation to establish level of workmanship for evaluating overall performance under contract documents. Furniture Installation Manager shall monitor and certify workmanship of each installer to ensure compliance with mock-up installation. **[Contractor shall demonstrate an understanding of assembly and integration of office furniture system components.]** Furniture Installation Manager shall obtain Project Director/COR's approval of completed mockups before starting systems furniture installation. Contractor shall protect mock-up installation from damage or other compromise.

1. Mock-up installations shall be agreed upon prior to installation. Installations shall include range of workmanship requirements, including connections to electrical and telecommunications systems, signage coordination, and lighting.
2. **[Mock-ups shall include furniture as identified in agreed-upon drawings for demonstration of open plan condition for both non-CAA and CAA, including distribution of electrical, telecommunications, and audio/visual within furniture. Installation shall include freestanding furniture and furnishings.]**
3. **[Include furniture as identified in agreed-upon drawings for demonstration of closed office condition where electrical and telecommunications are accessed at wall. Installation shall include freestanding furniture and accessories.]**
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Installation team to provide Phasing Installation updates and reports to Project Director/COR and OBO Interior Designer including but not limited to: missing products, punch-list items, explanation of deviations from tagged furniture plans provided by Government.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Scheduling Parameters Interface: Refer to Article on SCHEDULING PARAMETERS for key scheduling related to delivery of GFE furniture.

B. Receiving and Storage Timing: Scheduling Delivery of GFCI FF&E to Contractor's CRP must be done accurately to avoid damaging furniture while stored for extended periods.

1. Central Receiving/Consolidation Point (CRP): Contractor shall establish CRPs in U.S. OBO furniture Vendors will ship all GFCI FF&E, both secure and non-secure, to Contractor at these locations.

   a. [Secure CRP: For CAA furniture only, Contractor shall establish secure CRP. This CRP shall be located near an embarkation point. Refer to paragraph on "Secure Logistics" in this Article and Division 01 for requirements.]
   b. Contractor is responsible for off-loading shipments from vendors at this CRP.

2. Storage of Containers on Site: Contractor shall establish storage at the project site where items will be received from Contractor's CRP.

   a. [For CAA furniture only, containers shall be stored in Secure Storage Area (SSA). Refer to paragraph on "Secure Logistics" in this Article and in Division 01 for requirements.]

3. Protection of GFCI Items: From the time of receipt of GFCI FF&E at Contractor's CRP, Contractor is responsible to protect furniture from damage, from theft, and from exposure to adverse weather. Prolonged storage of these materials on site increases potential for damage to fabrics and finishes.

C. [Security Logistics: For CAA furniture only, Contractor shall provide secure logistics. See requirements in Division 01 Section "Construction Security," Section "Temporary Security Facilities and Controls," and Section "Secure Shipment."

1. Contractor is responsible for:

   a. Arrangements for advance security clearances for installation personnel.
   b. Process and responsibilities for protection of furniture from compromise during execution of Work. Project warehousing controls at secure CRP and SSA.
   c. Installation requirements related to the use of cleared American contractors and local labor force.

2. **Individual Shipping Plan: Contractor shall develop and implement Individual Shipping Plans for CAA office furniture systems, freestanding furniture and accessories.]**

D. Contractor Review of Vendor Purchase Order: Refer to Article on COORDINATION.

E. Receiving Reports: Contractor shall submit receiving reports to the Government within seven calendar days of receipt of goods at Contractor's CRP. Government will certify vendor payments and file claims based on Contractor's receiving reports. Failure to identify and report discrepancies within established timeframe will be Contractor's liability, as will any interest accrued in vendor interest payments. Receiving reports shall include items listed below. In addition, Contractor shall notify USG of damages in accepted deliveries within 48 hours, and notify USG of deliveries which are not accepted by Contractor within 24 hours. Contractor shall prepare and submit Receiving Reports to confirm receipt of all FF&E as per Vendor Orders and identify any damaged materials

1. Include date of delivery and quantities of each item identified in packing list.

   a. Packing List from the GC Warehouse shall provide the following information:

      1) Number of pallets received
      2) Dimensions (L x W x H) per pallet
      3) Number of cartons and/or boxes per pallet
      4) Weight of pallet
      5) Identify received line items from the OBO PO and OBO PO Number
      6) Quantities of each line item received
      7) Date items received

2. Include digital photographs of evident damage to packaging, attempted date of delivery/rejection of delivery, and of damage to individual furniture items.
3. Include discrepancies between packing list and the Government's Purchase Order shall be noted at time of delivery on trucker's bill of lading. These shall also be identified in receiving report.
4. Include printed name and signature of receiving individual.

F. Pre-Shipment Inspection of Site: Contractor shall arrange for Furniture Installation Manager to complete site inspection visit prior to commencing shipment of Government-furnished materials. Timing of inspection shall be consistent with requirement to minimize time furniture will be stored in containers on site. Furniture Installation Manager shall determine availability of facilities for access, delivery, and physical restrictions imposed by separate building trades. Inspection shall also include confirmation of critical dimensions and locations of power feeds by field measurement and identification of conflicts with air distribution systems, light switches, thermostats, etc. and that buildings environment is controlled.

   1. Contractor shall submit written Pre-Shipment Inspection Report prepared by Furniture Installation Manager to Project Director/COR 14 days prior to shipping GFCI FF&E to Post.

1.6 PROJECT CONDITIONS

A. Environmental Limitations in Buildings: Contractor shall not install GFE furniture until applicable building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining the interior at designated permanent settings.

B. Floor Tolerances: Floors must meet tolerances established by systems furniture manufacturer.

C. Weather Limitations on Site: Contractor shall transfer furniture from on-site storage to building for installation only when existing and forecasted weather permits work to be performed in accordance with manufacturer's written instruction and warranty requirements.

1.7 SCHEDULING PARAMETERS

A. CRP Delivery Period:

1. Delivery of GFCI FF&E: Contractor shall establish 90-day window with Start ("no earlier than") and Finish ("no later than") dates, during which delivery of GFCI FF&E to Contractor's CRP. All furniture shall be received at Central Receiving/Consolidation Point (CRP) during 90-day period. This window must be coordinated with OBO's preparation of GFCI FF&E purchase orders and subsequent shipment of items to construction site.

B. Confirmation of 90 day window of furniture delivery shall be obtained, and Project Execution Schedule adjusted accordingly.

1. Confirmation of GFCI FF&E CRP delivery dates: Contractor shall confirm in writing to Project Director/COR 400 days in advance of delivery of furniture to their CRP. This confirmation will initiate OBO's procurement process for GFCI FF&E and will establish period when items are to be delivered to Contractor's CRP. This Letter should also include shipping requirements and furniture phasing information.
2. Scheduling Delivery of GFCI FF&E to Contractor's CRP and subsequently to construction site must be done accurately to avoid damaging the furniture while stored for extended periods, during extra handling due to delays and storage in shipping containers.

1.8 COORDINATION

A. Coordination of procurement, delivery, shipment, and installation of GFCI FFE is essential to successful incorporation of these items within a project. The basis for organizing work are dates for furniture activities established in Baseline Project Schedule.

B. **[E-binder Office Systems Furniture Configuration: OBO will prepare an e-binder that includes systems furniture overall floor plans, typical workstations and clusters configurations and respective bill of materials for each workstation and/or cluster, based on final A/E design. Configurations will be more detailed and complete than final A/E design. The e-binder will be uploaded in Projnet in accordance with dates included in approved Project Execution Schedule to assist with Contractor's coordination effort.]**

C. Vendor Purchase Order: OBO will upload the Vendor Purchase Orders and Bill of Materials (BOM) in ProjNet as soon as they are available. Contractor shall review (BOM) and supply discrepancy report prepared by Furniture Installation Manager, and shall include comments and discrepancies on accuracy and quantity take-offs of all FF&E and specifications based on final OBO Furniture Installation Drawings, and identify any coordination issues with electrical, telecommunications, architectural elements, and other construction work.

D. Update of Drawings for Coordination: Refer to Article on SUBMITTALS for requirement to prepare Coordination Drawings.

E. Related Units of Work and Related Government Installation: Contractor shall coordinate GFE furniture installation with related units of work specified in other Sections, and with installation interface with associated Government-Installed items (e.g., co-located functional equipment) to ensure that Government–Furnished products associated with this Section can be installed and supported as indicated and per Design Intent.

1. Includes products requiring "critical measurements."
2. Includes interfacing wall and other construction to ensure that actual dimensions correspond to established critical dimensions.
3. Includes interfacing architectural millwork and casework.
4. Includes interfacing interior finishes.
5. Includes interior specialties, operational equipment, and furnishings.
6. Includes electrical and telecommunications in-feeds.

1.9 EXTRA MATERIAL MANAGEMENT

A. To extent that Government provides extra materials or that spare parts remain available, Contractor has responsibility for inventorying, packaging with protective covering for storage, and labeling contents for identification.

PART 2 - PRODUCTS

2.1 [OFFICE SYSTEMS FURNITURE

A. Products: GFCI products are produced by Allsteel, Haworth, or MillerKnoll. Systems furniture may include a single furniture system or combination of product lines.

B. Systems furniture will mostly be placed in open office area, but in some cases may be installed in closed office spaces.]

2.2 FREESTANDING NON-RESIDENTIAL FURNITURE

A. Products: Government-Furnished products are produced by various commercial furniture vendors or suppliers.

2.3 RESIDENTIAL FURNITURE

A. Products: Government-Furnished products are produced by various commercial and residential furniture vendors or suppliers

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine floors and conditions, with Contractor's Furniture Installation Manager present, for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work. Correct unsatisfactory conditions prior to proceeding with Work.

B. The Work requires finished ceiling grid and tiles; walls primed with final finish coat dry to touch; final floor finish in place; power, data and communications ready for distribution; environmental controls in service and operation, and only superficial punchlist items outstanding.

C. Inspect furniture components, removing and replacing components that are warped, bowed, deformed or otherwise damaged.

1. Refer to Article on FIELD QUALITY CONTROL process of addressing any missing or damaged items.

3.2 PREPARATION

A. Clean prior to proceeding with, including vacuuming floors and removal of dust, dirt, and debris.

3.3 INSTALLATION

A. Install furniture systems and freestanding furniture shall be in accordance with manufacturer's instructions to include coordination of blocking requirements for any FF&E components that are wall mounted.

B. Manufacturer Installation Instructions and Installation Tools: Contractor is responsible for acquiring necessary manufacturer's installation instructions and any specific tools required to successfully complete installation of Government-Furnished product.

3.4 FIELD QUALITY CONTROL

A. Inspection and Acceptance: OBO Project Director/COR and OBO/PDCS/DE/ID Interior Designer will complete inspection of the work on site to verify quantities and identify any defects, damage, deficiencies or failure to conform to contract requirements. Contractor payment for the Work is contingent on this inspection and acceptance.

B. Notify Project Director/COR of any missing or damaged items. Contractor is responsible for ordering replacement items and for all costs including purchase, shipping, and installation associated with those items.

1. Work may be repaired or refinished if it complies with requirements and shows no evidence of repair or refinishing.
2. Contractor is required to provide a punch list inspection report prior to departure of site.

3.5 CLEANING AND PROTECTING

A. Clean Government-Furnished products to produce ready-for-use condition.

B. Protection of Work: Contractor may allow separate contractors and building trades to continue to be engaged in punchlist and commissioning activities. The Work requires protection from

damage or theft, covering of exposed surfaces and secure areas where Work is complete. Contractor assumes liability for replacement of destroyed, damaged or lost property.

3.6 DEMONSTRATION

A. Training: Contractor shall provide training to Locally Engaged Staff (LES), managed by post's Facility Management office, in assembly and maintenance of the Government–Furnished products.

1. Include training minimum of three LES employed by post.
2. **[Include demonstration and training of use of systems furniture e-binder as directions for installation, us of any tools, templates or products provided by the vendor and specific to the product.]**
3. Include hands-on exercise where trained employees can demonstrate efficacy in installation and maintenance skills.

END OF SECTION 125005

SECTION 125705 - WORK BENCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Work benches and associated stools as identified in Construction Drawings.

B. Related Sections include the following:

1. Section 115700 “Shop Equipment.”
2. Section 125005 “GFE Furniture Installation.”

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer’s specifications and installation instructions, dimensions of individual components and profiles, material descriptions and thickness, rated capacities, bracing, accessories, fasteners, and finishes.

1. Each work bench.
2. Stools.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film, corrugated cardboard or other suitable material.

B. Shop work benches in this Section shall be packaged and set up for on-site placement using forklift.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install shop furniture until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 BASIS-OF-DESIGN

A. Product Designations: Work benches reference manufacturer's catalog numbers as the Basis-of-Design. Subject to compliance with requirements of this Section, other manufacturers' work benches of similar sizes, similar drawer configurations may be considered.

2.2 WORKBENCHES

A. Shop Work Benches:

1. Shop Work Bench Type A1 (OBO Component Code FN104):

a. Basis-of-Design Model: Strong Hold 63-W-303-6DB-12B or equivalent.
b. Dimensions: 1800 mm (72 inches) length x 750 mm (30 inches) depth x 1800 mm (72 inches) total height.
c. Load Capacity: 544 kg (1,200 lbs).
d. Material: 2.78mm (12-gauge) steel with an electrostatically-coated power paint finish.
e. Drawers: Two stacked 152mm (6 inch) high drawers side-by-side with four stacked 75mm (3 inch) high drawers.
f. Shelving: Three adjustable shelves below working surface.
g. Bins: Twelve small along rear of working surface.
h. Power: One electrical outlet strip w/ minimum four receptacles that meet local plug configurations and are protected with GFCI.
i. Lock: 3-point locking system.

2. Shop Work Bench Type A2 (OBO Component Code FN105):

a. Basis-of-Design Model: Jamco UN472GP or equivalent.
b. Dimensions: 1800 mm (72 inches) length x 900 mm (36 inches) depth x 850 mm (34 inches) height.
c. Load Capacity: 1,360kg (3,000 lbs).
d. Material: (12-gauge) steel with an electrostatically-coated power paint finish.
e. Drawers: Two stacked 127mm (5 inch) x 406mm (16 inch) wide drawers under bench top and to one side (allowing open space under the other side of the bench top).

3. Shop Work Bench Type A3 (OBO Component Code FN103): Wood working bench.

a. Basis-of-Design Model: Rockler – Beech N2000.
b. Dimensions: 1820 mm (72 inches) length x 496 mm (19-1/2 inches) width x 864 mm (34 inches) height.
c. Working Area: 0.99 sq m (10.7 sq ft).
d. Edge Thickness: 82.6 mm (3-1/4 inch).
e. Center Thickness: 30 mm (13/16 inch).

f. Wood Species and Finish: Beech with linseed oil finish.
g. Shelving: One shelf below work surface.
h. Vise: Quick acting type. Install with securely bolted stainless steel fasteners.

1) Front Width: 359 mm (14-1/8 inch)
2) Front Max. Opening: 146 mm (5-3/4 inch).
3) Tail Width: 292 mm (11-1/2 inch).

4. Shop Work Bench Type A4 (OBO Component Code SQ086): Rolling, Work Bench.

a. Basis-of-Design Model: KNAACK StorageMaster 58 or equivalent.
b. Dimensions: 1.37 m (54 inches) length x 660 mm (26 inches) width x 940 mm (37 inches) height.
c. Load Rating: 1,202 kg (2,650 lbs.).
d. Material: Steel, heavy duty.
e. Caster Size: 152 mm (6 inches) diameter.
f. Caster Type: Two fixed with lock, two swivel.
g. Locking System: Standard key cylinder lock.

5. Shop Work Bench Type A5 (OBO Component Code SQ029): Rolling, Toolbox.

a. Basis-of-Design Model: PROTO JSTV4239RD14RG or equivalent.
b. Dimensions: 558 mm (22 inches) length x 1066 mm (42 inches) width x 978 mm (38.5 inches) height.
c. Storage Capacity: 0.21 m^3 (12,427 in^3).
d. Load Rating: 816 kg (1,800 lbs.).
e. Material: Steel, heavy duty.
f. Caster Size: 152 mm (6 inches) x 51 mm (2 inches).
g. Caster Capacity: 204 kg (450 lbs.) per caster.
h. Caster Type: Two fixed with lock, two swivel.
i. Locking System: Standard key cylinder lock.

6. Shop Work Bench Type A6 (OBO Component Code SQ288): Mobile, Work Bench.

a. Basis-of-Design Model: Tennsco MB-3-2545 or Equivalent.
b. Dimensions: 635 mm (25 inches) length x 1.22 m (48 inches) width x 1.02 m (40 inches) height.
c. Load Capacity: 454 kg (1,000 lbs.).
d. Material: Steel.
e. Handle: Electronic with MHE-25 Push Handle Power Strip or equivalent.
f. Drawers: Three stacked high drawers with two box drawers and a file drawer.
g. Door Unit: Single lockable storage cabinet with one adjustable shelf.
h. Bins: Twenty bin box compartments.

7. Shop Work Bench Type A7: Mobile Tool Cabinet.

a. Basis-of-Design Model: Uline H-8947BL or Equivalent.

b. Dimensions: 1067 mm (42 inches) length x 485 mm (19 inches) width x 1.02 m (40 inches) height.
c. Load Capacity: 952.5 kg (2100 lbs).
d. Material: Steel.
e. Color: Black.
f. Drawers: 11 drawers Lockable.
g. Caster Size: 127 mm (5 inches).
h. Caster Type: Two fixed with lock, two swivel.

8. Shop Work Bench A8 (OBO Component Code: FN024): Table, Drafting.

a. Basis-of-Design Model: Diversified Spaces DT-9SA30 or Equivalent.
b. Dimensions: 900 mm (36 inches) length x 600 mm (24 inches) width x 750 mm (30 inches) height.
c. Load Capacity: 226.8 kg (500 lbs).
d. Material: Wood.
e. Top Material: Laminate.
f. Tilt: 17 to 90 degrees.

B. Technical Work Benches:

1. Technical Work Bench Type A (OBO Component Code FN027):

a. Basis of Design Model: Wright Line/Eaton ‘TechBench’ or equivalent.
b. Dimensions: 1800 mm (72 inches) wide x 750 mm (30 inches) deep x 1930-2134 mm (76-84 inches) adjustable total height.
c. Factory assembled ready-to-install vertical workbench system designed to accommodate computer technicians.
d. Features and Accessories:

1) Adjustable frame package with static controlled (ESD) laminate top.
2) 1800 mm (72 inches) ESD upper laminate shelf.
3) 1200 mm (48 inches) organizer frame.
4) 475 mm (19 inches) high x 600 mm (24 inches) wide white board.
5) 900 mm (36 inches) high x 600 mm (24 inches) wide peg board.
6) Three small bin rails.
7) One case of 24 quantity of 75 mm (3inch) parts bins.
8) Suspended pedestal with 150 mm (6 inch) x 300 mm (12 inch) drawers.
9) Keyboard/mouse platform.
10) Slatwall-mounted articulating monitor arm.

2. Technical Work Bench Type B (OBO Component Code FN079):

a. Basis-of-Design Model: Wright Line/Eaton ‘TechBench’ or equivalent.
b. Dimensions: 1800 mm (72 inches) wide x 750 mm (30 inches) deep x 1930-2134 mm (76-84 inches) adjustable total height.
c. Factory assembled ready-to-install vertical workbench system designed to accommodate computer technicians.

d. Features and Accessories:

1) Adjustable frame package with laminate top.
2) 1800 mm (72 inches) upper laminate shelf.
3) 1200 mm (48 inches) organizer frame.
4) 475 mm (19 inches) high x 600 mm (24 inches) wide white board.
5) 900 mm (36 inches) high x 600 mm (24 inches) wide peg board.
6) Three small bin rails.
7) One case of 24 quantity of 75 mm (3inch) parts bins.
8) Mobile storage under-cabinet; 750 mm (30 inches) high with four 150 mm (6 inch) drawers.

3. Packing Workbench Type (OBO Component Code FN283):

a. Basis-of-Design Model: Global Industrial 'Complete Packing Workbench with Riser & Lower Shelf Kit' or equivalent.
b. Dimensions: 1830 mm (72 inches) wide x 915 mm (36 inches) deep x 1930-2134 mm (76-84 inches) adjustable total height.
c. Factory assembled ready-to-install vertical workbench system designed to accommodate packing and wrapping parcels and supply storage.
d. Features and Accessories:

1) Adjustable frame package with 45 mm (1-3/4 inch) thick maple safety top.
2) Adjustable heavy-duty tubular steel legs and leveling floor glides.
3) 1200 mm (48 inch) riser kit with bin rail, reel holder, and adjustable shelves with carton dividers.
4) One case of 24 quantity of 75 mm (3inch) parts bins.
5) Lower shelf kit with four carton dividers and storage shelf.

2.3 MATERIALS

A. Metal: Cold-rolled commercial steel sheet, complying with ASTM A 1008/A 1 008M; matte finish; suitable for exposed applications.

B. Minimum Metal Thickness: Manufacturer's standard.

2.4 STEEL SHEET FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Factory finish steel surfaces and accessories except stainless-steel and chrome-plated surfaces.

C. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond. Use manufacturer's standard methods.

D. Baked-Enamel Finish: Immediately after cleaning, pretreating, and phosphatizing, apply manufacturer's standard thermosetting baked-enamel finish. Comply with paint manufacturer's written instructions for application, baking, and minimum dry film thickness.

2.5 STOOLS

A. Provide workbench stools from same manufacturer as the workbench. Finish shall match workbench.

1. Height: Accommodate ergonomically sufficient height for workbench seating.

2.6 HARDWARE

A. General: Provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Pulls: Manufacturer's standard pulls.

C. Drawer Slides: Powder-coated, full-extension, self-closing, heavy-duty drawer slides; designed to prevent rebound when drawers are closed; with nylon-tired, ball-bearing rollers; complying with BHMA A156.9, Type B05091, and rated for 670 N.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions.

B. Shop Work Benches: Place units in final locations after finishes have been completed in each area.

C. Technical Work Benches: Coordinate the delivery and placement of the Technical Work Benches with the GFE Furniture installation.

D. Install level, plumb, and true; shim as required, using concealed shims.

E. Adjust work benches and hardware so drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING AND PROTECTION

A. Inspect each item of work bench. Make necessary adjustments.

B. Verify that accessories required have been furnished and installed.

C. Remove packing material from shop furniture and leave units in clean condition, ready for use.

END OF SECTION 125705

SECTION 133435 – MAIL SCREENING FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes prefabricated mail screening facility.

B. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete.”
2. Section 099602 “High-Performance Coatings for General Usage.”
3. Section 115355 “Class I Biological Safety Cabinet.”

1.2 SUBMITTALS

A. Product Data.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For each type of exposed control finish required.

D. Product test reports.

E. Operations and Maintenance manuals.

F. Installation Instructions: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. See Article on DELIVERY, STORAGE, AND HANDLING for inclusion of these Instructions with shipping of facilities to project site.

G. Field Testing of Biological Safety Cabinet: Documentation of field testing, as required in Article on FIELD QUALITY CONTROL.

1.3 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," AWS D1.2, "Structural Welding Code--Aluminum," and AWS D1.3, "Structural Welding Code--Sheet Steel."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in National Electrical Code (NFPA 70) Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 COORDINATION

A. Coordinate installation of anchorages for mail screening facility. Deliver such items to Project site in time for installation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, panels, HVAC unit, biological safety cabinet, and work table and other manufactured items inside of prefabricated facility so as to avoid damage or deformity to these components or the overall facility during shipping. Package panels for protection during transportation and handling.

B. Ship the anchor bolts with unit, including anchoring dimensions and installation instructions.

C. Ship Installation Instructions with manufactured facility; see Article on SUBMITTALS.

D. Unload, store, and erect components in a manner to prevent damage.

1.6 WARRANTY

A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Charleston; Marine Containers Corporation (CMCI)
2. Veyka Construction Inc
3. RedGuard.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

1. Sheet: ASTM B 209M.
2. Extruded Shapes: ASTM B 221M.

3. Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T4 or 6061-T6.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

C. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, Z275 coating designation; mill phosphatized.

D. Galvanized, Rolled Steel Tread Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 380; hot-dip galvanized according to ASTM A 123/A 123M.

E. Steel Structural Tubing: ASTM A 500, Grade B, hot-dip galvanized according to ASTM A 123/A 123M.

F. Steel Mechanical Tubing: ASTM A 513, welded steel mechanical tubing, hot-dip galvanized according to ASTM A 123/A 123M.

G. Stainless-Steel Sheet: ASTM A 666, Type 304.

H. Plastic Laminate: NEMA LD 3, HGS or HGL grade.

I. Plywood: DOC PS 1, Exterior grade.

J. Particleboard: ANSI A208.1, Grade M-2.

K. Anchorages: Anchor bolts, stainless steel.

2.3 PREFABRICATED MAIL SCREENING FACILITY

A. General: Other than HVAC unit, biological safety cabinet, and work table, prefabricate and assemble most of the facility, ready for installation on Project site. Mail screening facility shall be capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into facility interior. Include structural framing, roof and wall panels, doors, as well as items identified in the Part 2 Article on COMPONENTS, MATERIALS AND ACCESSORIES; all of those shall comply with requirements of this Section. Provide means for anchoring facility to foundation.

1. Two-Room Facility (Standard): For mail screening facilities 4.88 m or more in length, divide facility into two rooms; Initial Screening Area and Secondary Screening Area, each area conforming to requirements identified below.
2. **[One-Room Facility (for applications with limited site space): For mail screening facilities shorter than 4.88 m, there shall only be one room conforming to requirements identified below. Use of One-Room Facilities first requires written approval of DS/WMD or OBO/DE/ME Mail Screening Facility COR.]**

B. Dimensions: Two-room mail screening facilities shall be nominal 6m x 2.5m x 2.5m**.**. Longer dimensioned facilities require written approval by Mail Screening Facility COR or Project Director. To facilitate shipment, in no case shall dimensions exceed ISO 668 – Series 1C freight containers.

C. Facility Configuration - Two-Room Facility:

1. Initial Screening Area: Initial screening area will be occupied when mail is delivered and screened.

   a. Exterior Door: 1220 mm (4 feet) width.

2. Secondary Screening Area (for opening suspect mail): Secondary area will normally be unoccupied, and shall be accessible only through the initial screening area. Separate secondary area from initial screening area by one wall with door having a swing into initial screening area.

   a. Door: 915mm with louver. Interior door shall have transfer louver sized for larger of ventilation fan or Biological hood exhaust.
   b. Class I Biological Safety Cabinet mounted on work table with cabinet's exhaust through side wall.
   c. Room Light Interlock: Class I Biological Safety Cabinet's on/off light switch shall be located in initial screening area behind door of secondary screening area, and shall simultaneously activate Class I Biological Safety Cabinet's dedicated power receptacle and lights. On/Off switch for Class I Biological Safety Cabinet shall always be in the "On" position.

D. [Facility Configuration - One-Room Facility:

1. Exterior Door: 1220 mm (4 feet) width.
2. Class I Biological Safety Cabinet mounted on work table with cabinet's exhaust through side wall.
3. Room Light Interlock: Class I Biological Safety Cabinet's on/off switch shall always be in the on position. Light switch shall simultaneously activate Class I Biological Safety Cabinet's dedicated power receptacle and screening area lights.]

2.4 COMPONENTS, MATERIALS AND ACCESSORIES

A. Electrical Power Service:

1. Two-Room Facility:

   Provide 60-A of electrical capacity at local power characteristics.
   a. Provide three duplex power receptacles in initial screening area, and two duplex power receptacles in secondary screening area, at local power characteristics. One of receptacles in secondary screening area shall be a dedicated power receptacle serving only the Class I Biological Safety Cabinet. Receptacles shall each be grounded.

2. [One-Room Facility:

   a. Provide 40-A of electrical capacity at local power characteristics.
   b. Provide four duplex power receptacles, each grounded.]

3. Breaker (Electrical) Panel: Single-phase, 3-wire load center, with not less than 4 open circuits; located adjacent to entry door. Run copper wiring in conduit.

B. Lighting Fixtures: Provide a minimum of 645 Lux (60 foot candles) lighting level at working level of 915 mm in each screening area, as applicable. Lighting fixtures shall be LED, waterproof, and dustproof. Fixtures and switches shall conform to NEMA 3 minimum.

C. Telephone Jacks: Provide one for each screening room, for termination by others.

1. Two-Room Facility: One jack in each screening area.
2. [One-Room Facility: One jack for facility]

D. HVAC Unit: Provide system to maintain temperature between 16 and 25 degrees Celsius year round.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into this work include but are not limited to:

a. Bard HVAC.

2. Digitally thermostatically controlled, through-the-wall unit, utilizing local power characteristics and providing ventilation/make-up air. Refrigerant shall be either R407c or R410a.

E. Ventilation Fan for Two-Room Facility: Two room mail screening facilities in locations having extreme temperatures (colder than -17 deg C or warmer than 38 deg C) requires continuous conditioned air to secondary screening room. Provide 15 l/s fan installed in wall which divides secondary and initial screening rooms.

F. Exhaust Termination: Provide wall cap on exterior of facility with integral backdraft damper and bird screen.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into this work include but are not limited to:

a. Broan-NuTone LLC.

2. Exhaust Connection: 152 mm.
3. Flange Size: 228 mm x 228 mm.

G. Decontamination Water Piping Components: One external hose bibb shall be piped to two internal hose bibbs located in each screening room (initial and secondary). Install external hose bibb on exterior skin of facility to allow hose connection. Do not make permanent water connection; unit is served by hose connection for decontamination purpose only. Provide one 15 m garden hose for use on interior hose bibb.

H. Duress Buttons: Coordinate with compound duress system, with work for termination of buttons by those involved with that system.

1. Two-Room Facility: Provide and install duress button on interior wall inside secondary room.
2. **[One-Room Facility: Provide and install duress button on wall to right of biological hood.]**
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into this work include but are not limited to:

    a. GE Security 3045-W Panic switch with terminals.

I. Metal Coated Exposed Finish: Finish exposed metal surfaces, including structural framework, walls, canopy, and ceiling with pigmented aliphatic acrylic polyurethane coating system.

J. Other Interior Wall and Ceiling Finishes: Non-metal surfaces shall be finished with washable semi-gloss or gloss enamel paint.

K. Sheet Vinyl Floor Covering With Backing: ASTM F 1303 or equal.

1. Type (Binder Content): II, minimum binder content of 34 percent.
2. Backing Class: Class A (fibrous).
3. Wear-Layer Thickness: Grade 1, 1.52 mm thick
4. Wearing Surface: Smooth.
5. Overall Thickness: 2.0 mm thick.
6. Sheet Width: 1.8 meters.
7. Seaming Method: Heat welded.
8. Heat-Welding Bead: Solid-strand product of floor covering manufacturer. Color to match floor covering.
9. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm per ASTM E 648.
10. Sanitary radius cove at intersection of floor and walls.
11. Integral-Flash-Cove Strip: 25 mm radius provided or approved by floor covering manufacturer.
12. Cap Strip: Square metal, vinyl, or rubber cap provided or approved by floor covering manufacturer.

L. Work Table: Provide commercial grade kitchen stainless steel table to span width of secondary room.

1. Material: 1.9 mm thick, stainless steel sheet.
2. Depth: Sufficient depth to support biological safety cabinet.
3. Height: 813 mm above finished floor.

2.5 FABRICATION

A. Fabricate mail screening facility completely in factory.

B. Prewire mail screening facility at factory, ready for connection to service at Project site.

C. Seal all interior and exterior penetrations (e.g., lights, electrical panel, switches) at walls and ceiling with waterproof caulk to prevent damage from weather or from interior/exterior pressure wash.

D. Fabricate mail screening facility with removable lifting eyes on roof.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

A. [Mail screening facility shall be placed within 60 meters of a water hydrant to allow a temporary connection for decontamination purposes only.]

B. Install mail screening facility on 100-mm- thick concrete, asphalt, or gravel base that is 305 mm larger than facility on all sides.

C. Set mail screening facility plumb and aligned. Level base plates true to plane with full bearing on bases.

D. Anchor mail screening facility to foundation.

E. Connection of Services: Where mail screening facilities are provided as part of a larger project, connection of services below is normally performed as the Work of other Sections. Where mail screening facilities are procured by post as a standalone effort, post will identify responsibility for these connections.

1. Connection of electrical power service to power distribution system is addressed in Division 26 Sections.
2. Connection of telephone line to telephone jack is addressed in Division 27 Sections.
3. Connect duress button to compound technical security system; refer to Section 282605 “Technical Security Duress Systems.”
4. Permanent connection of decontamination water supply is prohibited.

F. Work Table: Install stainless steel work table in secondary room.

G. Biological Safety Cabinet: Install biological safety cabinet on stainless steel table with exhaust ductwork through side wall; see Section 115355 “Class I Biological Safety Cabinet.”

1. Install and connect two 2-meter grounding rods.
2. Secure table and biological safety cabinet to prevent movement.

3.2 FIELD QUALITY CONTROL

A. After completing installation, inspect exposed finishes and repair damaged finishes.

B. Perform and document field testing to verify functionality of biological safety cabinet in accordance with installation instructions of manufacturer of biological safety cabinet; see Section 115355 "Class I Biological Safety Cabinet."

3.3 ADJUSTMENTS

A. Adjust doors and door hardware to operate without binding.

B. Lubricate hardware and other moving parts.

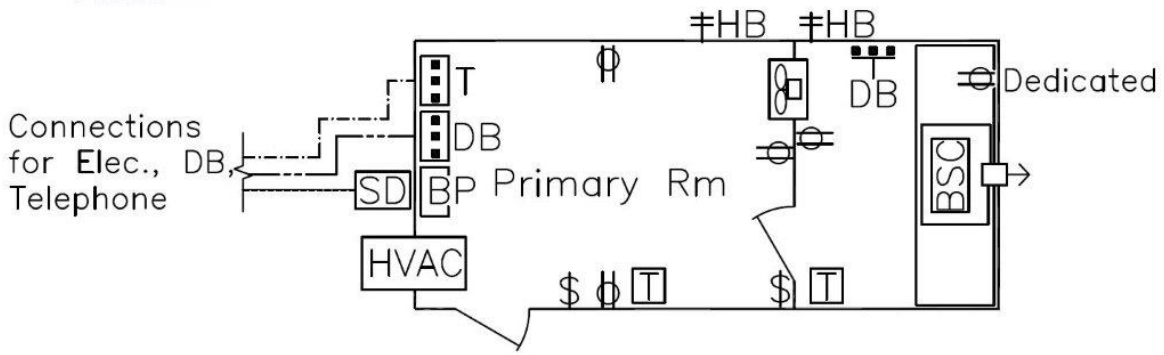
C. Seal seams with clear silicone gel seal.

3.4 ILLUSTRATIVE CONFIGURATION OPTIONS FOR TWO-ROOM MAIL SCREENING FACILITY:

A. See Attachments A, B, and C for illustrations of three potential configurations of the facility, customizable to location of entry to facility. In addition, see Attachment D for Legend with notes that applies to all three configurations.

END OF SECTION 133435

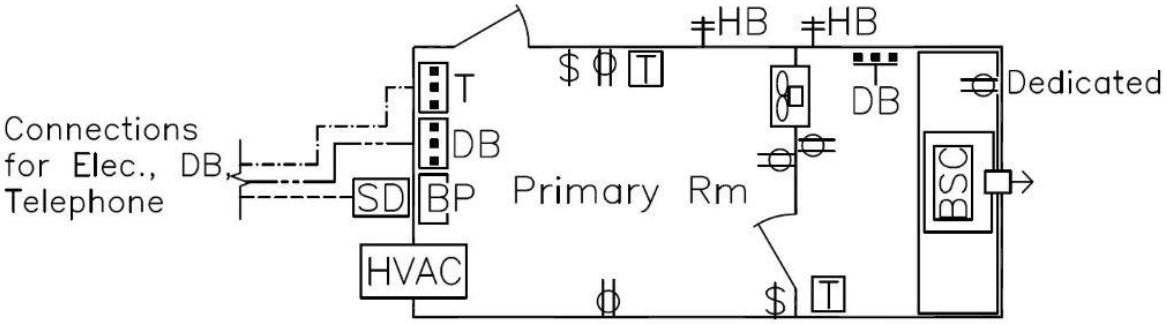
ATTACHMENT A – FRONT ENTRY LAYOUT



MAIL SCREENING FACILITY
LAYOUT A

Legend: See Attachment D.

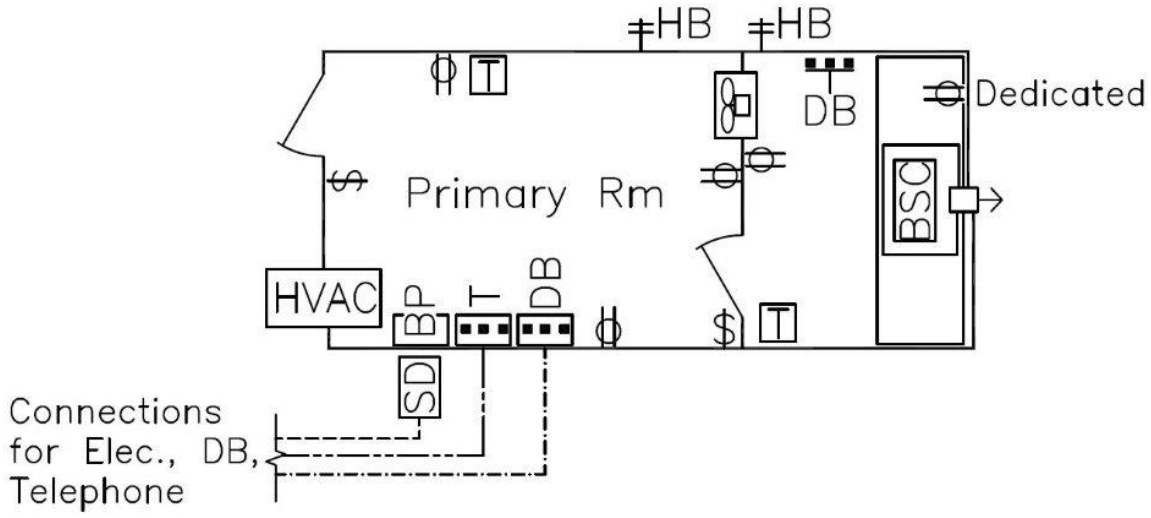
ATTACHMENT B – REAR ENTRY LAYOUT



MAIL SCREENING FACILITY
LAYOUT B

Legend: See Attachment D.

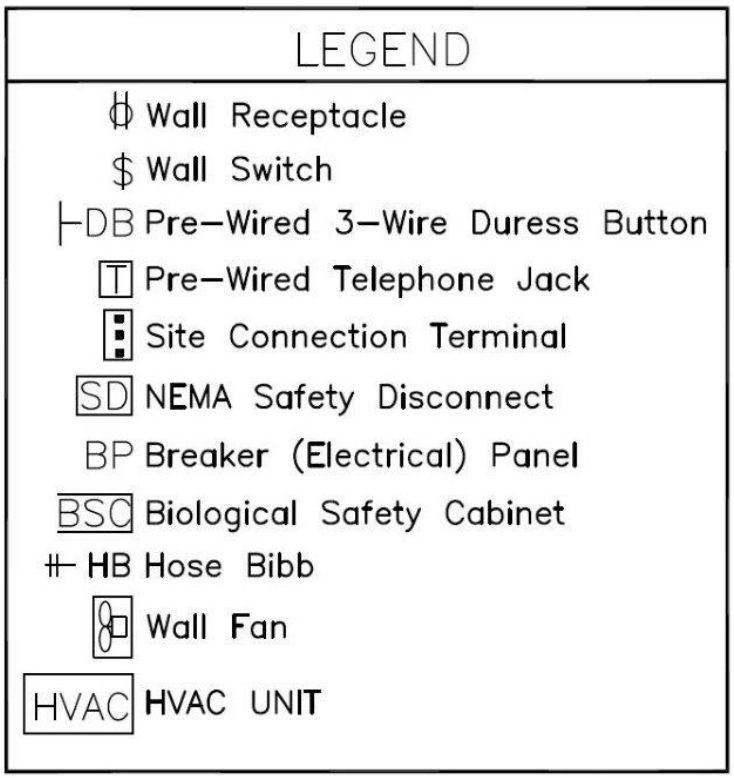
ATTACHMENT C – END ENTRY LAYOUT



MAIL SCREENING FACILITY
LAYOUT C

Legend: See Attachment D.

ATTACHMENT D – LEGEND FOR ILLUSTRATIVE FACILITY CONFIGURATIONS



General Notes: For the following, also see Part 2 of this Section for more specific requirements.

- HVAC Unit: Heat pump or A/C per project conditions
- Ventilation Fan between rooms: Place on room-separating wall.
- Secondary Room Light Switch: Place on exterior wall of Initial Room, near hinge side of door at room-separating wall (i.e., "hidden" by door when door is fully opened); interconnect switch with bio safety cabinet hood.
- Duress Button: Within Secondary Room; place on room-separating wall next to door latch.
- Hose Bibbs: One external hose bibb piped to two internal hose bibbs (one in each room)

SECTION 142105 – ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes machine-room-less electric traction passenger and service elevators. The project includes the following number of elevators:

1. Passenger Elevators: **[XX].**
2. Passenger/Service Elevators: **[XX].**

B. Related Requirements:

1. Division 01 Section "Temporary Facilities and Controls" for temporary use and elevators for construction purposes.
2. Division 01 Section "Operation and Maintenance Data."
3. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
4. **[Division 04 Section on unit masonry for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator frames installed in masonry walls.]**
5. **[Division 05 Section on structural steel framing for the following:**

   a. **Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.**
   b. **Divider beams.**
   c. **Hoist beams.**
   d. **Structural-steel shapes for sub-sills.]**

6. Section 055005 "Metal Fabrications" for the following:

   a. Attachment plates and angle brackets for supporting guide-rail brackets.
   b. Divider beams.
   c. Hoist beams.
   d. Structural-steel shapes for subsills.
   e. Pit ladders.
   f. Cants in hoistways made from steel sheet.

7. Section 057005 "Decorative Metal" for combination hall push-button stations.
8. Division 09 Section on **[xxx xxx]** for finish flooring in elevator cars.
9. Division 09 Section on interior painting for field painting of hoistway entrance doors and frames.
10. [Division 10 Section on wire mesh partitions for guards between adjacent elevator pits.]
11. Division 22 Section on sump pumps for sump pumps, sumps, and sump covers in elevator pits.
12. Section 230905 "Instrumentation and Controls for HVAC" for interface with the building automation system (BAS).

13. Division 26 Sections for interface with the general electrical system, including interface with the automatic transfer switch (ATS).
14. Section 271505 "Communications Horizontal Cabling" for telephone service for elevators and connection to elevator controllers for remote monitoring of elevator performance.
15. Section 284626 "Addressable Fire Alarm System" for smoke detectors in elevator lobbies to initiate emergency recall operation**[and heat detectors in shafts [and machine rooms]to disconnect power from elevator equipment before sprinkler activation]** and for connection to elevator controllers.

1.2 APPLICABLE CODES AND STANDARDS

A. General:

1. Applicability of either U.S. Codes/Standards set or Non-U.S. Codes/Standards set cited below is dependent upon which set is utilized by vendor servicing elevator.

   a. Refer to Article on QUALITY ASSURANCE for support service capability related to distance from project site. Refer also to Article on ACTION SUBMITTALS; the accepted submittal identifies which Codes/Standards set is used by servicing vendor, and hence which set governs for this Section.

2. Applicability of NFPA Codes: All elevators shall additionally conform to NFPA Codes identified below.

B. U.S. Codes and Standards Set:

1. ASME A17.1/CSA B44 "Elevator and Escalator Safety Code." When there is a Security requirement for installation by cleared Americans. Current addition at the time of Award.
2. Accessibility standards identified in Chapter 11 of the OBO Building Code, which amend the Architectural Barriers Act (ABA).

C. Non-U.S. Codes and Standards Set:

1. ISO 14798: "Risk Assessment."
2. EN 81-20: "Safety Rules for the Construction and Installation of Lifts" (Electric Lifts).
3. EN 81-21: "New Passenger and Goods Passenger Lifts in Existing Buildings."
4. EN 81-28: "Remote Alarm on Passenger and Goods Passenger Lifts."
5. EN 81-50: "Safety Rules for the Construction and Installation of Lifts."
6. EN 81-58: "Landing Doors Fire Resistance."
7. EN 81-70: "Accessibilities to Lifts for Persons Including Persons with Disability."
8. EN 81-71: "Vandal Resistant Lifts."
9. EN 81-72: "Firefighters' Lifts."
10. EN 81-73: "Behavior of Lifts in Event of Fire."
11. EN 81-77: "Safety Rules for the Construction and Installation of Lifts."

D. NFPA Codes:

1. OBO Electrical Code (NFPA 70 "National Electric Code" as amended by OBO).

2. NFPA 72 "National Fire Alarm and Signaling Code."

1.3 DEFINITIONS

A. Definitions: Refer to ASME A17.1/CSA B44 or EN 81-20, as applicable to this project (see Article on APPLICABLE CODES AND STANDARDS).

B. Authority Having Jurisdiction (AHJ): The overall AHJ is OBO Elevator Management (OBO/OPS/FAC/PS). Host Country local AHJ's may also have limited jurisdiction.

C. Passenger/Service Elevator: A passenger elevator with horizontal side sliding doors and a cab configuration where the depth of the cab is greater than the width that is also used to carry freight.

1.4 ACTION SUBMITTALS

A. General: Initial set of Action Submittals shall include all the following submitted together:

1. Product data.
2. Shop drawings.
3. Qualification data, including identification of applicable Codes/Standards set.

B. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control, and signal systems. Requires approval of Manufacturer, model, and coordinated components by OBO Elevator Management.

C. Shop Drawings:

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
2. Include large-scale layout of car-control station and standby power operation control panel. Provide a detailed drawing for the elevator alarm control panel in Marine Security Guard Post 1.
3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

D. Samples for Initial Selection: For finishes involving color selection.

E. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 75-mm (3-inch) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.

F. Qualification Data: Document required qualifications as identified in Article on QUALITY ASSURANCE. Requires approval by OBO Elevator Management.

1. Installer.

2. Support Service and Maintenance Technicians. Include information on location of local service center. Identify whether U.S. Codes/Standards set or Non-U.S. Codes/Standards set govern operations of service vendor; see Article on APPLICABLE CODES AND STANDARDS.

G. Contractor Pre-Testing Inspection: Written verification by Contractor that installation is 100 percent completely tested with full load.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and control closet layout and dimensions, as shown on Drawings, and electrical service including standby power generator, as shown and specified, are adequate for elevator system being provided.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

B. Testing Procedures for Elevator Safety Features: Submit manual in English and local language that describes all procedures.

C. Inspection and Acceptance Certificates and Operating Permits: As required by local Authorities Having Jurisdiction for normal, unrestricted elevator use.

D. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

E. Training:

1. Training Manuals.
2. Instructor's name and resume, with emphasis on experience in presenting training programs.
3. List of attendees.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Elevator manufacturer or an authorized representative who is factory trained and certified by manufacturer and has been approved by OBO Elevator Management (OBO/ OPS/FAC/ PS). The Installer shall have a minimum of five years' verifiable experience installing elevator equipment that similar to equipment in this Project.

B. Support Service Capability: Manufacturer-approved support services vendor to start-up generator, and available to provide ongoing maintenance services. Vendor shall be located within 50 km (30 miles) of project site. Vendor shall have performed these services on this product line for at least five years.

1. Maintenance Technician Qualifications: Local elevator technicians who will maintain elevators shall have certified factory training; the service company and personnel shall be approved by OBO Elevator Management.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Materials and components shall be stored off the ground, under cover, and in a dry location.

1.9 COORDINATION

A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations and dimensions of other work relating to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance sub-sills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, control spaces, and machine rooms.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
2. Warranty Period: One year from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include full maintenance by skilled employees of elevator Installer throughout the Project warranty period or for 12 months, whichever is greater. In addition, provide maintenance service for elevator used for construction purposes; see Article on PROTECTION. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance during normal working hours.
2. Perform emergency callback service during normal working hours with response time of one hour or less.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.
4. During the 12th month of Maintenance required by the Contract, the Contractor shall perform (NO LOAD) safety test and inspection that will be witnessed by OBO Elevator management.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Only manufacturers that have local support service office as required in Article on QUALITY ASSURANCE, have systems which comply with the requirements of this Section, and which have demonstrated capability to perform the work of this Project and have support service capability as identified in Article on Quality Assurance. Other manufacturers than the ones listed below will only be considered when approved by OBO Elevator Management (OBO/OPS/FAC/PM).

1. KONE, Inc.
2. Otis Elevator Co.
3. Schindler Elevator Co.
4. ThyssenKrupp Elevator.
5. NIDEC Elevator Co.

B. Basis of Design:

1. **[XXX]** by **[YYY].**

C. Source Limitations:

1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Requirements: Comply with Chapter 11 of the OBO Building Code related to ABA-based accessibility requirements for elevators or EN 81-70 Accessibility Standard, as applicable for this project (see Article on APPLICABLE CODES AND STANDARDS).

B. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Elevator safety requirements shall comply with ASME A17.1/CSA B44 or EN 81-77, as applicable for this project (see Article on APPLICABLE CODES AND STANDARDS). Where Non-U.S. Codes/Standards are used, Installer shall identify design acceleration (Ad) to determine the European seismic zone level.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Affected peak velocity acceleration (Av) for Project's location is to be provided and confirmed by the elevator manufacturer.
3. Provide earthquake equipment as required by ASME A17.1/CSA B44 or EN 81-77, as applicable to this project (see Article on APPLICABLE CODES AND STANDARDS).
4. Provide seismic switch where required by ASCE/SEI 7.

   a. The seismic switch shall be designed to be fail safe and have a battery backup to prevent an intermittent loss of power from initiating earthquake operation.

5. Design earthquake spectral response acceleration at short periods (S_s) for Project is **[0.XX] [identified in Construction Drawings]**.
6. Design earthquake spectral response acceleration at one-second period (S_1) for the Project is **[0.XX] [identified in Construction Drawings]**.
7. Building Seismic Design Category is **[X for xxx building and Y for yyy building(s)] [identified in Construction Drawings]**.
8. Elevator Component Importance Factor: **[1.0]**.

2.3 ELEVATOR SYSTEM

A. Elevator System, General: Only manufacturer's standard designed certified elevator systems are acceptable. Manufacturer's standard components shall be used for each elevator. Integrated packages made up from components of multiple manufacturers are not acceptable.

B. Shared Elevator Attributes: The following attributes are common for all elevators in the project.

1. Machine Location: Hoistway; no machine room is provided, but control room is required adjacent to elevator in top occupied floor.
2. Machine Type: Gearless traction.
3. Operation System: Selective-collective automatic operation.
4. Auxiliary Operations:

    a. Standby power operation.
    b. Battery-powered rescue operation.
    c. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44 or EN 81-77, as applicable for the project (see Article on APPLICABLE CODES AND STANDARDS).
    d. Automatic dispatching of loaded car.
    e. Nuisance call cancel.
    f. Independent service.
    g. Loaded-car call bypass.
    h. Automatic releveling when car is loading or unloading with car and landing doors open.
    i. Car door restrictor devices to prevent opening car door when outside leveling zone.
    j. Dual machine brakes to be used during uncontrolled car movement and ascending overspeed operation.
    k. [In-car fire fighter operations for all elevators where required by Code.]
    l. Programmable operation of lights and ventilation fans to permit scheduled periods where these will be normally out of operation except at time when the elevators are used during those periods.

    m. [Distributed parking not at a security landing.]

5. Car Enclosures:

    a. Door Sills: Material shall be **[Bronze] [Nickel silver] [Stainless steel]**.
    b. Handrails: **[38 mm (1-1/2 inches) round] [13 by 50 mm (1/2 by 2 inches) rectangular] [satin stainless steel, No. 4 finish] [satin bronze, lacquered],** at sides and rear of car.

6. Hoistway Entrances:

    a. Frames: **[Enameled or powder-coated steel] [Satin stainless steel, No. 4 finish] [Satin bronze, lacquered]**.
    b. Doors: **[Enameled or powder-coated steel] [Satin stainless steel, No. 4 finish] [Satin bronze, lacqured]**.
    c. Sills: Material shall be **[Bronze] [Nickel silver] [Stainless steel].**

7. Additional Requirements:

    a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from **[satin stainless steel, No. 4 finish] [satin bronze, lacquered].**

C. Elevator **[[Group] XX]** Description:

1. **[Elevator Alphabetic Identification:]** Each elevator shall be identified with a unique alphabetic identification. Numeric and alphanumeric identification are prohibited.

2. Rated Load: **[900 kg (2000 lb)] [950 kg (2100 lb)] [1150 kg (2500 lb)] [1350 kg (3000 lb)] [1600 kg (3500 lb)] [1800 kg (4000 lb)] [2050 kg (4500 lb)] [2250 kg (5000 lb)] <INSERT VALUE>.**

3. **[Freight Loading Class for Passenger/Service Elevator(s): Class A.]**
4. Rated Speed: **[1.0 m/s (200 fpm] [2.5 m/s (500 fpm)] [3.6 m/s (700 fpm)] [4.1 m/s (800 fpm)] [5.1 m/s (1000 fpm)] [6.1 m/s (1200 fpm)] [7.1 m/s (1400 fpm)] <INSERT VALUE>**.
5. **[Auxiliary Operations:]**

    a. **[Emergency hospital] [Priority] service at [all] <INSERT FLOOR DESIGNATION> floors.]**

6. Security Features**:** No security features are for required for individual elevator; see Article on OPERATION SYSTEMS. Provide conductors and other components to facilitate potential for adding card reader at future time.
7. Car Enclosures:

    a. Inside Width: **[1600 mm (64 inches)] [1700 mm (68 inches)] [2000 mm (80 inches)] [2350 mm (92 inches)] <INSERT DIMENSION>** from side wall to side wall.
    b. Inside Depth: **<Insert dimension> [1300 mm (51 inches)] [1350 mm (53 inches)] [1450 mm (57 inches)] [1650 mm (65 inches)] [2200 mm (87-1/2 inches)] [2300 mm (90 inches)] [2350 mm (93 inches)] [2400 mm (93-1/2 inches)] [2450 mm (96 inches)] [2550 mm (101 inches)] [2600 mm (102 inches)] <INSERT DIMENSION>** from back wall to front wall (return panels).
    c. Inside Height: **[2250 mm (88 inches)] [2350 mm (92 inches)] [2400 mm (94 inches)] [2550 mm (100 inches)] [2650 mm (104 inches)] [2750 mm (108 inches)] [2850 mm (112 inches)] <INSERT DIMENSION>** to underside of ceiling.
    d. Front Walls (Return Panels): **[Satin stainless steel, No. 4 finish] [Satin bronze, lacquered].**
    e. Car Fixtures: **[Satin stainless steel, No. 4 finish] [Satin bronze, lacquered].**
    f. Side and Rear Wall Panels: **[Enameled steel] [Satin stainless steel, No. 4 finish] [Textured stainless steel] [Satin bronze, lacquered]**.
    g. Reveals: **[Enameled steel] [Satin stainless steel, No. 4 finish] [Satin bronze, lacquered]**.
    h. Door Faces (Interior): **[Enameled steel] [Primed steel] [Satin stainless steel, No. 4 finish] [Textured stainless steel] [Satin bronze, lacquered]**.
    i. Door Sills: **[Bronze] [Nickel silver] [Stainless Steel]**.
    j. Ceiling: **[Luminous ceiling] [Polished stainless steel, No. 8 finish] [Satin stainless steel, No. 4 finish] [Polished bronze, lacquered]**.
    k. Floor: **[Recessed and prepared to receive [ceramic] [dimension stone] tile [terrazzo] (specified in Division 09 Section] [Prepared to receive [resilient] [linoleum] flooring (specified in Division 09 Section)**.

8. Hoistway Entrances:

   a. Width: **[1300 mm (52 inches)] [1200 mm (48 inches)] [914 mm (36 inches)]**.
   b. Height: **[2100 mm (84 inches)] [2030 mm (80 inches]**.

   c. **[Type for XXX: [Single-speed side sliding] [Two-speed side sliding].]**
   d. **[Type for YYY: [Single-speed center opening] [Two-speed center opening]**.]

9. Hall Fixtures: **[Satin stainless steel, No. 4 finish] [Satin bronze, lacquered] [Recessed type with no exposed-metal surfaces].**

10. [Additional Requirements:

   a. Provide hooks for protective pads in all cars and two complete set(s) of full-height protective pads.]

2.4 TRACTION SYSTEMS

A. Elevator Machines: Permanent Magnet Variable-Voltage, Variable-Frequency, AC-gearless type hoisting machines are preferred.

   1. Provide regenerative drives systems.
   2. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
   3. Provide means for absorbing regenerated power when elevator system is operating on standby power.
   4. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

B. Fluid for Hydraulic Buffers: If using hydraulic buffers, use only fire-resistant fluid.

C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

D. Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 055005 "Metal Fabrications" for materials and fabrication.

E. Car Frame and Platform: Bolted- or welded-steel units.

F. Guides: Roller guides, non-lubricated. Provide guides at top and bottom of car and counterweight frames.

G. Suspension Means: Provide either Steel Traction Elevator Ropes or Coated Steel Belts with a FT-1 Fire rating

2.5 OPERATION SYTEMS

A. General: Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:

1. Group Standby Power Operation: On activation of standby power, cars are returned to a designated floor and parked with doors open.
2. **[Group Battery-Powered Rescue Operation: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered one at a time to the next floor below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.]**
3. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
4. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.
5. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
6. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed and distributed in predetermined zones throughout the building. One zone shall include the main floor and adjacent floors; remaining floors shall be divided into approximately equal zones.
7. Independent Service: Key-switch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from key-switch when car is in independent service. When in independent service, doors close only in response to door close button.
8. Emergency and Inspection panels (E&I) or Maintenance Access Panels (MAP) shall be located adjacent to top landing hoistway entrances.
9. Fire Access Elevators ; A minimum of two elevators that service all landings shall be provided in a high rise building

C. Security Operation Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

1. Marine Security Guard operation is required in all office buildings that have Post 1 and Marines providing security in the building.

D. Control Panel: Provide control panel for Post 1 Marine security guard station for elevator controls. This panel shall include car position indicator, three-position toggle switch with center “OFF,” and indicator lights mounted on engraved plate. Provide separate adjacent plate with instructions. Back box shall conform to applicable codes. Control panel features shall not affect emergency fire-fighting service.

1. Panel Face Plate: Surface mount stainless steel with No. 4 satin finish. Front of panel shall be permanently engraved with the designations below for toggle switch. With these letters at least 20 mm (3/4 inch) high.

   a. Top Position: "CAPTURE (doors locked)."
   b. Center Position: "NORMAL."
   c. Bottom Position: "NIGHT SHUTDOWN (doors open)."

2. Elevator Position Indicator: Provide digital type position indicator on top portion of panel which displays numbers/letters. Characters shall be minimum of 50 mm (2 inches) high showing floor location (e.g., 1, 2 or 3) and travel direction of each elevator.
3. Toggle Switch: Provide a three-position, heavy duty commercial toggle switch to select the "normal," "capture," and "night shutdown" modes.

   a. Capture Feature Operation: With the switch in the "capture (doors locked)" position, the operation of this security system is as follows.

      1) The green light (normal) will go out and the red light (capture) will blink.
      2) Hall calls shall be immediately canceled. The hall station call buttons, door-open button, and door-closed button shall be disabled.
      3) The elevator shall return non-stop to the ground floor lobby just as it would in the fire service recall mode.
      4) The car and hoistway doors shall remain in the closed position secured by retaining power on the car doors. Once the elevator is positioned at the ground floor, the doors can be opened by switching to the "night shutdown" position. The elevator will then remain at the ground floor with the doors open. Switching from the "capture" position to "night shutdown" position will cause the blinking red light to go out and the blue (steady-state) light to illuminate.
      5) The elevator shall remain at the first floor lobby until the switch is returned to the "normal" position, at which point the green (steady-state) light will illuminate.

   b. Night Shutdown: When toggle switch is pointing to "night shutdown (doors open)," sequence of operation is as follows.

      1) Green light "normal" shall go out, and blue (steady-state) light "night shutdown" shall illuminate.
      2) Hall calls shall be immediately canceled. Hall station call buttons, door-open button, and door-closed button shall be disabled.
      3) Elevator shall return non-stop to ground floor lobby just as it would in fire service recall mode.
      4) Car and hoistway doors shall open when at first floor lobby.
      5) Elevator shall remain at first floor lobby until switch is returned to "normal" position, at which point blue light shall go out and green (steady state) light shall illuminate.
      6) The car lights and fan shall turn off and not restart until switch is turned to Normal position.

4. Panel Indicator Lights: Provide red-blinking “capture” lamp, green “normal” lamp, and blue “shutdown” lamp as follows for each elevator.

   a. Red "capture" lamp shall be LED "blinking."
   b. Green "normal" lamp shall be LED.
   c. Blue "night shutdown" lamp shall be LED.

5. Instruction Plate: Provide separate engraved plate with No. 4 brushed stainless steel finish adjacent to elevator control panel which provides description of “Capture” and “Shutdown” modes. The words “capture” and “night shutdown” shall be engraved in black letters 8 mm (3/8 inch) high, with all other words engraved in black letters which are 6 mm (1/4 inch) high. This Instruction Plate shall be installed at same time as elevator control panel. This instruction plate shall include the following inscription:

   a. “CAPTURE: DISABLES PASSENGER COMMANDS. ELEVATOR RETURNS NON-STOP TO THE GROUND FLOOR AND PARKS WITH THE DOORS LOCKED CLOSED. DOORS ARE OPENED WHEN PUT IN THE SHUTDOWN MODE.”
   b. “NIGHT SHUTDOWN: DISABLES PASSENGER COMMANDS. ELEVATOR RETURNS TO GROUND FLOOR LANDING AND PARKS WITH THE CAR DOORS AND LOBBY DOORS IN THE OPEN POSITION AND THE CAR INTERIOR LIGHTS ARE OFF.”

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced door speed that reduces kinetic energy.

2.7 CAR ENCLOSURES

A. General: Provide steel-framed car enclosures with non-removable wall panels, with car roof, power door operators, and ventilation.

   1. Provide standard railings complying with ASME A17.1/CSA B44 or EN 81-20, as applicable for the project (see Article on APPLICABLE CODES AND STANDARDS) on car tops.

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

   1. [Subfloor: Exterior, underlayment grade plywood, not less than 16-mm (5/8-inch) nominal thickness for cars with resilient flooring.]

2. **[Subfloor: Exterior, C-C Plugged grade plywood, not less than 22-mm (7/8-inch) nominal thickness for cars with ceramic tile or dimension stone flooring.]**
3. Floor Finish: Specified in Division 09 Section on **[ceramic tile][dimension stone tile] [[resilient] [linoleum] flooring].**
4. **[Enameled-Steel Wall Panels: Flush, hollow-metal construction; fabricated from cold rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.]**
5. **[Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.]**
6. **[Bronze Wall Panels: Flush, hollow-metal construction; fabricated from bronze sheet.]**
7. Fabricate car with recesses and cutouts for signal equipment.
8. Fabricate car door frame integrally with front wall of car.
9. **[Enameled-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.]**
10. **[Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet or by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.]**
11. **[Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.]**
12. Sight Guards: Provide sight guards
13. Sills: Extruded or machined metal, with groove surface, 6 mm (1/4 inch) thick.
14. Luminous Ceiling: Provide LED cab light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
15. **[Metal]** Ceiling: Flush panels, with **[incandescent downlights in the center of][four low-voltage downlights in]** each panel. **[Align ceiling panel joints with joints between wall panels.]**

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 or EN 81-58 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.

1. Fire-Protection Rating: 1-1/2 hours with 30-minute temperature rise of 250 deg C (450 deg F).

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. **[Enameled-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect through Project Director/COR from manufacturer's full range.]**
2. **[Stainless-Steel Frames: Formed from stainless-steel sheet.]**
3. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches (76 mm) high, on both inside surfaces of hoistway door frames.
4. **[Enameled-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect through Project Director/COR from manufacturer's full range.]**
5. Sight Guards: Provide sight guards on doors matching door edges.
6. Sills: Stainless steel, with grooved surface, 6.4 mm (1/4 inch) thick.
7. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.9 SIGNAL EQUIPMENT

A. General: **[Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled.][Provide signal equipment designed for destination-based system.]** Fabricate lighted elements with LEDs.

B. Car-Control Stations: Provide manufacturer's standard **[recessed][semi-recessed]** car control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

C. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

1. Mark buttons and switches for function. Use both tactile symbols and Braille.
2. Provide "

D. Emergency Communication System: Hands-free audio two-way emergency communication between each car and Post 1. Television monitoring shall NOT be installed in cars. System automatically dials preprogrammed number of monitoring service and identifies elevator location to Post 1. System shall be contained in flush-mounted cabinet complete with identification; instructions for use, and battery back-up power supply, and complies with accessibility requirements in Chapter 11 of the OBO Building Code. Emergency communications shall direct calls to Post 1 first.

E. Communication System: Provide additional means to communicate between pit, top of car, and in-car to both Post 1 and emergency inspection control panel.

F. [Firefighters' Two-Way Telephone Communication Service: Provide [flush-mounted cabinet][telephone jack] in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Section 284626 "Addressable Fire Alarm Systems."]

G. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

H. Hall Push-Button Stations: Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group.

1. Provide **[manufacturer's standard wall-mounted units][units with flat faceplate for mounting with body of unit recessed in wall]**.
2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
3. Equip units with buttons for calling elevator and for indicating direction of travel.

I. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Section 284626 "Addressable Fire Alarm Systems."

J. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:

1. [Manufacturer's standard wall-mounted units, for mounting above entrance frames.]
2. [Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.]

K. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

L. Hall Position Indicators: Provide illuminated, digital-display-type position indicators, located above each hoistway entrance at ground floor. Provide units with flat faceplate for mounting and with body of unit recessed in wall.

1. Integrate ground-floor hall lanterns with hall position indicators.

M. [Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.]

N. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics in accordance with “Signage and Wayfinding Design Guide” reference document in

the OBO Design Standards, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall pushbutton station unless otherwise indicated.

2.10 FINISH MATERIALS

A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

E. [Textured Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 with embossed texture rolled into exposed surface.

1. Product: Subject to compliance with requirements, provide <INSERT PRODUCT NAME> by <INSERT MANUFACTURER'S NAME>.
2. Metal surface is [satin relieved] [titanium nitride colored] [oxide colored] [satin relieved and titanium nitride colored] [satin relieved and oxide colored] [color coated and satin relieved] [color coated and bright relieved] after texturing.]

F. Stainless-Steel Bars: ASTM A 276, Type 304.

G. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

H. [Bronze Plate and Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal).]

I. [Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).]

J. [Bronze Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).]

K. [Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.]

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions.

B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS D1.1M Structural Welding Code for workmanship and for qualifications of welding operators.

C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

F. Leveling Tolerance: 3 mm (1/8 inch), up or down, regardless of load and travel direction.

G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with non-shrink, nonmetallic grout.

H. Locate hall signal equipment for elevators as follows unless otherwise indicated:

1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
2. Place hall lanterns either above or beside each hoistway entrance.
3. Mount hall lanterns at a minimum of 1800 (72 inches) above finished floor.

3.3 FIELD QUALITY CONTROL

A. Contractor Pre-Testing Inspection: Contractor shall completely test that elevators are completed 100 percent prior to requesting OBO Elevator Management Program to witness acceptance testing and final inspection.

B. Acceptance Testing: Upon completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by local governing regulations and agencies. Acceptance testing shall be witnessed by OBO Elevator Management Program personnel as the Department of State AHJ for elevators.

C. Operating Test: Load elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. During a 30-minute test period record the temperature rise of elevator machine. Record failure to perform as required.

D. Advise Project Director/COR and OBO Elevator Management Program a minimum of 21 days in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTON

A. Temporary Use: Limit temporary use for construction purposes to one service elevator. Comply with the following requirements for elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train post Facility Maintenance personnel to operate**[, adjust, and maintain]** elevator(s).

B. Check operation of each elevator with post Facility Maintenance personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 142105

SECTION 144500 - VEHICLE LIFTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Heavy-duty four-post surface (above ground) vehicle lift.
2. Associated rolling bridge jacks.

B. Related Sections:

1. Section 033000 "Cast-In-Place Concrete" for thickened slab design to support vehicle lift.
2. Section 115700 “Shop Equipment” for general shop equipment associated with Vehicle Lift.
3. Various Division 26 Sections for general electrical infrastructure and requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design, engineer, fabricate, and install vehicle lift to withstand mass weight loads of not less than 5,500 kg (12,000 lbs).

B. Comply with the OBO Electrical Code (National Electrical Code, NFPA 70, as amended by OBO).

1.3 SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include Product Data for operation, control, and safety equipment.

B. Shop Drawings: Provide shop drawings including requirements for attachment to strengthened slab and connection to electrical.

C. Qualifications Data: If requested by Project Director/COR, submit list of facilities that have used specific model selected by Contractor for this project, with contact information for those facilities.

D. Maintenance Data: Include manufacturer’s original maintenance information to include in the Operation and Maintenance Manual Data.

E. Warranty: Properly executed warranties from manufacturer of vehicle lift, both as required by these Specifications, and as noted to be available by published product literature.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Vehicle lift manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Equipment Manufacturer: Equipment being offered shall be a model that has been in production for a minimum of five years.

C. Comply with ANSI/ALI/ALCTV "Standard for Automotive Lifts – Safety Requirements for Construction, Testing, and Validation."

D. Vehicle Lift shall bear American Lift Institute (ALI) certification label.

1.5 COORDINATION

A. Coordinate installation of items that are required to be embedded in concrete with on-site manager for concrete subcontractor in consultation with General Contractor. Furnish templates and installation instructions and deliver to Project site in time for installation.

B. Coordinate locations, routing, and dimensions of other work relating to lift including electrical service.

1.6 WARRANTY

A. Warranties: Provide standard manufacturer's written warranty, without monetary limitation, signed by manufacturer agreeing to promptly repair or replace products that fail in materials or workmanship for the following periods:

1. Structural Components: Five years from Substantial Completion.
2. Hydraulic Power Units and Cylinders: Two years from Substantial Completion.

PART 2 - PRODUCTS

2.1 VEHICLE LIFT (OBO COMPONENT CODE SQ025):

A. Basis-of-Design Product: Subject to compliance with requirements, provide BendPak HDS27 or comparable product:

B. Lifting height shall be 1740 mm (68-1/2 inches) minimum. This measurement is measured from floor to top of lifting pad when lift is at full height and when lifting pad is at its lowest position.

C. Provide redundant safety lock system.

1. One acceptable system includes gravity activated locks in each column, working independently of each other. The mechanical locks are released manually. Mechanical

locks re-engage automatically every time lift is raised. Mechanical locks allow operator to release locks and lower lift without continuing to hold lock release.

2. Another system with comparable level of protection may be used with approval of Project Director/COR.

D. Lifting Speed: 120 seconds minimum from floor to full height.

E. Lift Dimensions: Provide the following:

1. Hydraulic line may be adjustable to accommodate minimum vehicle height from undercarriage to roof to 1650 mm (66 inches).
2. Hydraulic line may be adjustable to accommodate minimum vehicle height from undercarriage to roof to 1650 mm (66 inches).
3. Width Between Columns: Approximate standard is 3,000 mm (10 feet). That dimension shall not be reduced.
4. Runway Heights: 215 mm (8-1/2 inches) minimum at lowest position when lift is all the way down.

2.2 HYDRAULICS

A. Lift shall incorporate primary/secondary hydraulic system capable of synchronizing elevations during both raising and lowering operations; this capability shall be achievable when most adverse rated load placed on lift. Lift shall come equipped with fully automatic leveling control and manual over-ride as back up.

B. Internal hydraulic safeties on both cylinders shall detect significant mainside-to-offside pressure differentials. Should pressure change or an imbalance occur for any reason, lift shall lock hydraulically on both sides.

C. Full load working pressure shall be maximum of 1,930 Mg per sq. m (2,750 psi). Higher pressure systems will not be accepted.

D. Provide external hydraulic safeties to prevent collapse in the event of leak, and mechanisms to limit descent speed.

2.3 POWER UNIT

A. Power unit may be mounted on either driver side or passenger side column. Provide manufacturer's standard unit compatible requirements for building.

B. Power unit shall conform to in-country electrical requirements for volts and hertz.

2.4 FABRICATION

A. Vehicles lifts shall be shop-fabricated and delivered to the project site ready for installation.

2.5 FINISHES

A. Steel Finishes: Provide powder coat or baked-enamel finish.

2.6 ACCESSORY UNIT

A. Rolling Bridge Jack (OBO Component Code SQ084): Provide jack that will be used in conjunction with vehicle lift.

1. Basis of Design Product: Subject to compliance with requirements, provide BendPak RJ-15 or comparable product.
2. Salient Characteristics:

a. Lifting Capacity: 6800 kg (15,000 lbs).
b. Width: 1120 mm (44 inches) min., 1475 mm (58 inches) max.
c. Arm Reach: 1145 mm (45 inches) min., 1475 mm (58 inches) max.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prepare substrate by cleaning, removing projections, filling voids, sealing joints, and as otherwise recommended in vehicle lift manufacturer's written instructions.

B. Set units level, plumb, and true to line, without warp or rack of frames and panels.

C. Fasten vehicle lift securely in place, with provisions for thermal and structural movement. Install with manufacturer-approved and supplied fasteners.

D. Dissimilar metals and metal products shall be separated from contact with wood or cementitious materials by painting each metal surface in area of contact with bituminous coating, or by other permanent separation.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: Upon completion of vehicle lift installation, and before permitting use of lift, perform acceptance tests, including any by local authorities having jurisdiction if applicable.

B. If vehicle lift equipment or its installation are deficient, repair or replace vehicle lift, and refinish if necessary as directed by Project Director/COR. If necessary for correction process, remove deficient vehicle lift.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating parts and hardware for smooth, quiet operation, and ready for use. Lubricate hardware and moving parts.

B. Clean equipment in accordance with manufacturer’s instructions.

C. Protect equipment from damage during remainder of construction period.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government's maintenance personnel to operate, adjust, and maintain vehicle lift.

1. Additionally include procedures related to start-up, normal operation, shutdown, manual operation, controls set-up and programming, and alarms for maintaining the vehicle lifts and associated rolling bridge jacks. Include interactions with compressed air systems.

B. Duration of training session shall meet the following:

1. Classroom: 1 hour
2. Field Demonstration: 1 hour

END OF SECTION 144500

SECTION 211305 – FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following building fire suppression piping:

1. Automatic wet-type, Class I standpipe systems.
2. Wet-pipe sprinkler systems.
3. Dry-pipe sprinkler systems.

B. Related Requirements:

1. Section 104415 “Fire-Protection Specialties” for cabinets and fire extinguishers.
2. Section 213115 "Fire Pump Assemblies" for fire pumps, pressure-maintenance pumps, and pump controllers.
3. Section 284626 "Addressable Fire Alarm Systems" for alarm devices not specified in this section.
4. Section 331414 "Fire Service Mains and Appurtenances" for piping and fire hydrants outside the building.

1.2 CODES AND STANDARDS

A. Codes: The OBO Building Code consists of the model International Building Code and OBO amendments in the OBO International Codes Supplements (OBO-ICS). Codes adopted by OBO are identified in Chapter 1 of the OBO-ICS IBC (supplement to the Building Code) for the year applicable to the project.

B. Standards:

1. National Fire Protection Association (NFPA): Fire-suppression system equipment, specialties, accessories, installation, and testing shall comply with the following:

a. NFPA 3, "Standard for Commissioning of Fire Protection and Life Safety Systems,” 2024 edition.
b. NFPA 4, "Standard for Integrated Fire Protection and Life Safety Systems Testing,” 2024 edition.
c. NFPA 13, "Standard for the Installation of Sprinkler Systems," 2022 edition.
d. NFPA 13D, "Standard for the Installations of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes," 2022 edition.
e. NFPA 13R, "Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,” 2022 edition.

f. NFPA 14, "Standard for the Installation of Standpipe and Hose Systems," 2022 edition.
g. NFPA 20, "Standard for the Installation of Stationary Pumps for Fire Protection," 2022 edition.
h. NFPA 22, “Standard for Water Tanks for Private Fire Protection,” 2023 edition.
i. NFPA 24, "Standard for the Installation of Private Fire Service Mains and Their Appurtenances," 2022 edition.
j. NFPA 25, “Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems,” 2023 edition.
k. NFPA 37, "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines," 2024 edition.
l. NFPA 72, "National Fire Alarm and Signaling Code," 2022 edition.
m. NFPA 170, “Standard for Fire Safety and Emergency Symbols,” 2021 edition.
n. NFPA 241, “Standard for Safeguarding Construction, Alteration and Demolition Operations,” 2022 edition.
o. NFPA 291, “Recommended Practice for Fire Flow Testing and Marking of Hydrants,” 2025 edition.

C. Conflicts: Where applicable codes and standards differ, notify OBO/OPS/FIRE/FPE through the Project Director/COR prior to action. The baseline direction will be to apply the more stringent requirement.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 1200 kPa (175 psig).

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 1200-kPa (175-psig) maximum.

1.4 ACTION SUBMITTALS

A. General: Submittal of all drawings, calculations, and product data, and qualifications will be deemed incomplete and not reviewed unless all are submitted together; an incomplete submittal will not be reviewed, and is considered not acceptable.

B. Product Data: For each type of product include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Pipes, fittings, and specialties.
2. Pipe hangers, supports, and braces
3. Cover system for sprinkler piping.
4. Specialty valves.
5. Sprinklers.
6. Alarm devices.

7. Manual control stations.
8. Control panels.
9. Pressure gages.
10. Air compressors.
11. Hose connections.
12. Fire department connections.
13. Other miscellaneous items used, Teflon tape, etc.

C. Shop Drawings: For standpipe and sprinkler systems. Prepare code compliant working plans according to NPFA 13, Chapter 22, including hydraulic calculations for acceptance by Project Director/COR based on approval by OBO/OPS/FIRE/FPE. Shop drawings shall be consistent with the Construction Drawing Set, including plans, schematics, and diagrams, which indicate general locations and arrangement of piping. Approved full size shop drawings both Set A & B are required to be onsite when the installation begins.

1. Include plans, elevations, sections, and attachment details.
2. Include hydraulic calculations in both SI (metric) and IP (imperial) units.
3. Include structural design calculations.
4. Include diagrams for power, signal, and control wiring.
5. Include water storage tank detail with water volume, water level monitoring, and other details required for water supply source.

D. Delegated-Design Submittal: For standpipe and sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer or NICET designer responsible for their preparation.

1. Submit product data, hydraulic calculations, seismic calculations, and the sprinkler shop drawings simultaneously as one package. Submit two full size hard copies and one electronic copy on a compact disk. Submittal will be deemed incomplete and not reviewed unless it is compliant with the information contained herein, and has attached all drawings, calculations and manufacturers information for review.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Architectural building features.

   a. Interior Walls.
   b. Partition Assemblies.
   c. Interior Soffits.

2. Domestic water piping.
3. Compressed air piping.
4. HVAC hydronic piping.

5. Items penetrating finished ceiling include the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. HVAC equipment.

B. Qualification Data:

1. Lead Installer: Provide Journeyman/Journeyperson license from any state or federal program that requires at least a 4-year fire protection apprentice program or a notarized copy of qualifying certificate (NICET III or higher in water based fire protection systems layout or licensed fire protection engineer) to OBO/OPS/FIRE prior to installation.
2. For Qualified Individual and Professional Engineer or NICET designer, furnish a notarized copy of qualifying certificate (NICET III or higher in water based fire protection systems layout or licensed fire protection engineer) to OBO/OPS/FIRE prior to installation.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved OBO/OPS/FIRE/FPE and accepted by the Project Director/COR, including hydraulic calculations, product data, and seismic calculations.

D. Welding certificates.

E. Fire-hydrant flow test report or recent fire pump test report.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 3, 4, 13, and 14. Include "Contractor's Material and Test Certificate for Aboveground Piping."

G. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For standpipe and sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1. Operation and Maintenance manuals shall include:

   a. Instructions on stopping.
   b. Shutdown instructions for each type of emergency.
   c. Operating instructions for conditions outside normal operating limits.
   d. Required sequences for electric or electronic systems.
   e. Special operating instructions and procedures.
   f. Locations of all drains.

1.7 QUALITY ASSURANCE

A. Fire-Suppression standpipe and sprinkler systems design shall be approved by OBO/OPS/FIRE/FPE.

B. Manufacturer Qualifications: All components of the sprinkler system shall be supplied by a U.S. manufacturer. There shall be no deviations from this requirement except by written approval from OBO/OPS/FIRE/FPE through the Project Director/COR.

C. System continuity: A single installer shall be used for all aspects of the installation, including classified work and unclassified work. Fire pump shall be installed by same contractor as sprinkler system.

D. Installation Subcontractor Qualifications:

1. Installation subcontractor's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Design shall be in accordance with the required and advisory provisions of NFPA 13 and other applicable codes listed in the Article on CODES AND STANDARDS.
2. Lead Installer: The lead on-site fire protection system installer shall be a licensed sprinkler journeyman/journeyperson, NICET III or higher, or licensed fire protection engineer and have a minimum of five years hands-on recent experience in the design and installation of fire protection systems for the different building types included in this project.

   a. On-Site Presence: The Lead Installer shall be on-site from the beginning of the fire protection system installation through completion, including commissioning and acceptance. This individual shall furnish to OBO/OPS/FIRE thru the Project Director a monthly report detailing status of the job on a per- building / per-floor basis. This report shall include resolution of punch list items, if applicable, whether generator by contractor or OBO personnel.

3. Qualified Individual: Employ at least one person with current qualifications that meet the referenced standard (NICET III or higher or licensed fire protection engineer). This individual is ultimately responsible for the quality control of the installation. This person is designated as the qualified individual.

   a. Required Consultation: The qualified individual must meet and consult with site management and lead fire protection system installer to establish means and methods to install the fire protection system. This meeting shall be held prior to the installation of the fire protection system.
   b. On-Site Presence: The Qualified Individual shall be on-site as necessary to ensure quality control of the installation, but no less than as required by this specification under the Field Quality Control Section. Where issues arise with the quality of the installation, the government can require the Qualified Individual to be onsite until the issues have been resolved. The Qualified Individual shall be onsite for final acceptance testing and prepare all NFPA certificates for the project.

4. Engineering Responsibility: Contract Drawings shall be designed and approved by a qualified professional engineer. Preparation of working plans, calculations, and field test reports shall be by a qualified professional engineer and/or an individual with a minimum of NICET III certification in water based fire protection systems layout.

E. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Upon delivery, place equipment and components in storage in a manner to preclude damage from weather, humidity and temperature variations, dirt and dust, or other contaminates. All pipes shall either be capped or plugged until installed.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include at least two sprinklers of each type and temperature used on the project. Include sprinkler wrench for each type of sprinkler requiring a special wrench.

1.10 WARRANTY

A. Contractor's Warranty: Submit a written warranty agreeing to repair or replace any portion of the automatic sprinkler system that fails in materials or workmanship within a period of one year after the latter of substantial completion or sprinkler system final acceptance testing, which is witnessed by OBO/OPS/FIRE.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

A. Combined System: A standpipe system that supplies both hose connections and automatic sprinklers.

B. Automatic Wet-Type, Class I Standpipe System: Includes DN 65 (NPS 2-1/2) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

C. Automatic Dry-Type, Class I Standpipe System: Includes DN 65 (NPS 2-1/2) hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air or nitrogen. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer or NICET designer to design Class I standpipe systems.

1. Standpipe system design shall be approved by OBO/OPS/FIRE/FPE. Standpipe systems shall meet the pressure and flow requirements of the local fire department and the following:

a. Minimum residual pressure at each hose-connection outlet shall be 450 kPa (65 psig).
b. Flow Rate:

1) Minimum flow rate for the hydraulically most remote standpipe shall be 1893 L/min (500 gpm).
2) Minimum flow rate for each additional standpipe shall be 946 L/min (250 gpm).
3) The maximum flow rate shall be 3785 L/min (1000 gpm) for buildings that are sprinklered throughout, in accordance with NFPA 13, and 4731 L/min (1250 gpm) for buildings that are not sprinklered throughout.

2. Hydraulic calculations shall be prepared according to NFPA 14 criteria.

B. Standard-Pressure Piping System Component: Listed for 1200-kPa (175-psig) minimum working pressure.

C. High-Pressure Piping System Component: Listed for **[1725-kPa (250-psig) minimum] [2070-kPa (300-psig)]** working pressure.

D. Delegated Design: Engage a qualified professional engineer or NICET designer to design sprinkler systems.

1. Sprinkler system design shall be approved by OBO/OPS/FIRE/FPE.

a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers, etc.
b. Sprinkler Occupancy Hazard Classifications:

1) Automobile Parking Areas: Ordinary Hazard, Group 1.
2) Building Service Areas: Ordinary Hazard, Group 1.
3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.

4) General Storage Areas: Ordinary Hazard, Group 1.
5) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
6) Office and Public Areas: Light Hazard.
7) Residential Living Areas: Light Hazard.
8) Food Preparation/Service Areas: Ordinary Hazard, Group 1.
9) Warehouse: Type IV commodity unless higher hazard is expected.

2. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 4.1 mm/min. over 139-sq. m (0.10 gpm over 1500-sq. ft**.)** area.
b. Ordinary-Hazard, Group 1 Occupancy: 6.1 mm/min. over 139-sq. m (0.15 gpm over 1500-sq. ft**.)** area.
c. Ordinary-Hazard, Group 2 Occupancy: 8.1 mm/min. over 139-sq. m (0.20 gpm over 1500-sq. ft.**)** area.
d. Extra-Hazard, Group 1 Occupancy: 12.2 mm/min. over 232-sq. m (0.30 gpm over 2500-sq. ft.**)** area.
e. Extra-Hazard, Group 2 Occupancy: 16.3 mm/min. over 232-sq. m (0.40 gpm over 2500-sq. ft.**)** area.

3. Maximum Protection Area per Sprinkler: According to UL listing of the sprinkler, but not greater than:

a. Office Spaces: 20.9 sq. m (225 sq. ft.).
b. Storage Areas: 12.1 sq. m (130 sq. ft.).
c. Mechanical Equipment Rooms: 12.1 sq. m (130 sq. ft.**)**.
d. Electrical Equipment Rooms: 12.1 sq. m (130 sq. ft.).
e. Generator Rooms: 9.2 sq. m (100 sq. ft.).
f. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

a. Light-Hazard Occupancies: 6.3 L/s (100 gpm) for 30 minutes.
b. Ordinary-Hazard Occupancies: 15.75 L/s (250 gpm) for 60 to 90 minutes.
c. Extra-Hazard Occupancies: 31.5 L/s (500 gpm) for 90 to 120 minutes.

5. Hydraulic calculations shall be prepared according to NFPA 13 criteria for Area/Density method. The use of quick response reductions are not permitted.

E. Water Supply: Base hydraulic calculations on results of pump test when supply takes suction from compound fire protection water tank; in the uncommon case where fire protection water is supplied directly from the municipal system, which is indicated on Construction Drawings if applicable, base calculations on the result of the flow test associated with that system.

F. Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined according to OBO-ICS IBC Chapter 16, NFPA 13 and ASCE/SEI 7, "Minimum Design Loads for Buildings and Other Structures," Section 9, "Earthquake Loads".

2.3 MANUFACTURERS

A. In other Part 2 Articles, where titles introduce lists of available manufacturers, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the manufacturers specified.

2.4 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A795. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in DN 125 (NPS 5) to DN65 (NPS 2 1/2); and NFPA 13-specified wall thickness in DN 150 to DN 250 (NPS 6 to NPS 10), plain end.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with ends matching joining method.

D. Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.

E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Uncoated, Malleable-Iron Threaded Fittings: ASME B16.3.

G. Malleable- or Ductile-Iron Unions: UL 860.

H. Cast-Iron Flanges: ASME B16.1, Class 125.

I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 3.2 mm (1/8 inch) thick, ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.

   a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
   b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

K. Grooved-Joint, Steel-Pipe Appurtenances:

1. Available Manufacturers:

a. Anvil International, Inc.
b. Central Sprinkler Corp.
c. Ductile, Inc.
d. JDH Pacific, Inc.
e. National Fittings, Inc.
f. Shurjoint Piping Products, Inc.
g. Southwestern Pipe, Inc.
h. Star Pipe Products; Star Fittings Div.
i. Victaulic Co. of America.
j. Ward Manufacturing

2. Pressure Rating: 1200-kPa (175-psig) minimum.
3. Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.5 DIELECTRIC FITTINGS

A. Where dielectric fittings are required due to connection of dissimilar metals, all system piping shall be flushed to clear all systems of any debris within the piping before connections with the dielectric fittings.

B. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

C. Dielectric Unions: Factory-fabricated assembly, designed for 1725 kPa (250 psig) minimum working pressure at 82 deg C (180 deg F). Including insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastic Company.
c. Epco Sales, Inc.
d. Hart Industries International, Inc.

e. Watts Industries, Inc.; Water Products Div.
f. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated companion-flange assemblies, for 1200 kPa (175 psig) minimum working-pressure rating as required for piping system.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric Flange Insulation Kits: Components for Field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.

1. Available Manufacturers:

a. Advanced Products and Systems, Inc.
b. Calpico, Inc.
c. Central Plastic Company.
d. Pipeline Seal and Insulator, Inc.

F. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 2070 kPa (300 psig) working-pressure rating at 107 deg C (225 deg F).

1. Available Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 2070 kPa (300 psig) working-pressure rating at 107 deg C (225 deg F).

1. Available Manufacturers:

a. Perfection Corporation.
b. Precision Plumbing Products, Inc.
c. Victaulic Co. of America

2.6 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 1200-kPa (175-psig) minimum.
2. High-Pressure Piping Specialty Valves: 1725-kPa (250-psig) minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Grooved.

F. Dry-Pipe Valves:

1. Standard: UL 260.
2. Design: Differential-pressure type. Low differential pressure vales and accelerators are not permitted. Valve must be a positive latching style.
3. Include UL 1486, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

G. Air-Pressure Maintenance Device:

1. Standard: UL 260.
2. Type: Automatic device to maintain minimum air pressure in piping.
3. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 95- to 410-kPa (14- to 60-psig) adjustable range, and 1200-kPa **(**175-psig**)** outlet pressure.

H. Air Compressor:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Motor Horsepower: Fractional.
3. Power: 120-V ac, 60 Hz, single phase.

I. Main System Check Valves:

1. Standard: UL 193
2. Pressure Rating: 1200-kPa (175-psig) minimum.
3. Installation: Designed for vertical installation.
4. Body Material: Cast iron, ductile iron, or bronze with bronze grooved seat with O-ring seals, single-hinge pin, and latch design
5. Trim: Include trim sets for drain, electrical sprinkler alarm switch, and pressure gages.

J. Automatic (Ball Drip) Drain Valves:

1. Available Manufacturers:

a. AFAC Inc.
b. Grinnell Fire Protection.

2. Standard: UL 1726.
3. Pressure Rating: 1200-kPa (175-psig) minimum.
4. Type: Automatic draining, ball check.
5. Size: DN 20 (NPS 3/4).
6. End Connections: Threaded.

2.7 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Available Manufacturers:

   a. Anvil International, Inc.
   b. Central Sprinkler Corp.
   c. Ductile, Inc.
   d. JDH Pacific, Inc.
   e. National Fittings, Inc.
   f. Shurjoint Piping Products, Inc.
   g. Southwestern Pipe, Inc.
   h. Star Pipe Products; Star Fittings Div.
   i. Victaulic Co. of America.
   j. Ward Manufacturing

2. Standard: UL 213.
3. Pressure Rating: 1200-kPa (175-psig) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved or threaded.
9. Mechanical-tee and –cross fittings are not permitted for new construction.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 1200-kPa (175-psig) minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig (1200 kPa) (175 psig).

3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: [**1200-kPa (175-psig) minimum**] [**2070 kPa (300 psig)**].
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Available Manufacturers:

   a. CECA, LLC.
   b. Merit

2. Standard: UL 1474.
3. Pressure Rating: 1725-kPa (250-psig) minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Vic-Flex, or comparable product by one of the following:

   a. Flex Head Corp.
   b. Viking Corp.

2. Standard: UL 2443 and FM 1637.
3. Type: Fully stainless steel AH2 flexible hose for connection to sprinkler, and with one-piece open-gate “Series AB1” bracket for connection to ceiling grid.
4. Bend Radius: The bend radius shall have a minimum of at least 53 mm (2 in.).
5. Number of Bends: The hose shall be listed for four bends at 775 mm (31 in.) length, five bends at 900 mm (36 in.) length, eight bends at 1200 mm (48 in.) length, ten bends at 1500 mm (60 in.) length, and twelve bends at 1800 mm (72 in.) length. Union joints shall be provided for ease of installation.
6. Pressure Rating: 1200-kPa (175-psig) minimum.
7. Size: Same as connected piping, for sprinkler.

8. Ceiling Grid: Integrity of ceiling grid materials inclusive of support system must meet minimum requirements of NFPA 13 and product listing.
9. Cross Listing: Both the ceiling grid assembly and the sprinkler hose must be cross listed for compatibility.

2.8 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 1200 kPA (175 psig) minimum pressure ratings.

B. Two-Piece Ball Valves With Indicators

1. Available Manufacturers:

a. NIBCO.
b. Victaulic Co. of America.

2. Description:

a. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
b. Minimum Pressure Rating: 1200 kPa (175 psig).
c. Body Design: Two piece.
d. Body Material:

1) DN40 (NPS 1-1/2) and smaller: Forged brass or bronze.
2) DN50 and DN65 (NPS 2 and NPS 2-1/2): Bronze or ductile iron.
3) DN80 (NPS 3): Ductile iron.

e. Port Size: Full or standard.
f. Seats: PTFE.
g. Stem: Bronze or stainless steel.
h. Ball: Chrome-plated brass.
i. Actuator: Worm gear or traveling nut.
j. Supervisory Switch: Internal or external.
k. End Connections for Valves DN 25 (NPS 1) through DN 50 (NPS 2): Threaded ends.
l. End Connections for Valves DN 65 (NPS 2-1/2): Grooved ends.

C. Bronze Butterfly Valves With Indicators

1. Available Manufacturers:

a. Globe Safety Products, Inc.
b. Milwaukee Valve Company.
c. Central Sprinkler Corp.
d. McWane, Inc.; Kennedy Valve Div.

e. Mueller Company.
f. NIBCO.
g. Pratt, Henry Company.
h. Victaulic Co. of America.

2. Description:

a. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
b. Minimum: Pressure rating: 1200 kPa (175 psig).
c. Body Material:

1) DN50 (NPS 2) and smaller: Bronze.
2) DN65 (NPS 2-1/2) and larger: Bronze, cast-iron, or ductile-iron body.

d. Seat Material: EPDM.
e. Stem Material: Bronze or stainless steel.
f. Disc: Bronze or stainless steel with EPDM coating.
g. Actuator: Worm gear or traveling nut.
h. Supervisory Switch: Internal or external.
i. Ends Connections for Valves

1) DN 25 (NPS 1) through DN 50 (NPS 2): Threaded ends.
2) DN 65 (NPS 2-1/2): Grooved or flanged ends.

D. Check Valves

1. Available Manufacturers:

a. AFAC Inc.
b. American Cast Iron Pipe Co.; Waterous Co.
c. Central Sprinkler Corp.
d. Clow Valve Co.
e. Crane Co.; Crane Valve Group, Crane Valves.
f. Crane Co.; Crane Valve Group, Jenkins Valves.
g. Firematic Sprinkler Devices, Inc.
h. Globe Fire Sprinkler Corp.
i. Grinnell Fire Protection.
j. Hammmond Valve.
k. Matco-Norca, Inc.
l. McWane, Inc.; Kennedy Valve Div.
m. Mueller Company.
n. NIBCO.
o. Potter-Roemer; Fire Protection Div.
p. Reliable Automatic Sprinkler Co., Inc.
q. Star Sprinkler Inc.
r. Stockham.

s. United Brass Works, Inc.
t. Venus Fire Protection, Ltd.
u. Victaulic Co. of America.
v. Watts Industries, Inc.; Water Products Div.

2. Description:

a. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
b. Minimum Pressure Rating: 1200 kPa (175 psig).
c. Type: Single swing check.
d. Body Material: Cast iron, ductile iron, or bronze.
e. Clapper: Bronze, ductile iron, or stainless steel.
f. Clapper Seat: Brass, bronze, or stainless steel.
g. Hinge Shaft: Bronze or stainless steel.
h. Hinge Spring: Stainless steel.
i. End Connections: Flanged, grooved, or threaded.

E. Bronze OS&Y Gate Valves

1. Available Manufacturers:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Hammond Valve.
c. NIBCO.
d. United Brass Works, Inc.

2. Description:

a. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
b. Minimum Pressure Rating: 1200 kPa (175 psig).
c. Body and Bonnet Material: Bronze or brass.
d. Size: DN50 (NSP 2) and smaller
e. Wedge: One-piece bronze or brass.
f. Wedge Seat: Bronze.
g. Stem: Bronze or brass.
h. Packing: Non-asbestos PTFE.
i. Supervisory Switch: External.
j. End Connections: Threaded.

F. Iron OS&Y Gate Valves

1. Available Manufacturers:

a. Clo- Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves

c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. Mueller Company.
g. NIBCO.
h. Victaulic Corporation of America.
i. United Brass Works, Inc.

2. Description:

a. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
b. Minimum Pressure Rating: 1200 kPa (175 psig).
c. Body and Bonnet Material: Cast or ductile iron.
d. Size: DN65 (NSP 2-1/2) and larger
e. Wedge: Cast or ductile iron, or bronze.
f. Wedge Seat: Cast or ductile iron, or bronze.
g. Stem: Brass or bronze.
h. Packing: Non-asbestos PTFE.
i. Supervisory Switch: External.
j. End Connections: Flanged or Grooved.

2.9 SPRINKLERS

A. Available Manufacturers:

1. AFAC Inc.
2. Central Sprinkler Corp.
3. Firematic Sprinkler Devices, Inc.
4. Globe Fire Sprinkler Corp.
5. Grinnell Fire Protection.
6. Reliable Automatic Sprinkler Co., Inc.
7. Star Sprinkler Inc.
8. Venus Fire Protection, Ltd.
9. Victaulic Co. of America.
10. Viking Corp.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 1200-kPa (175-psig) minimum.

D. Pressure Rating for High-Pressure Automatic Sprinklers: **[1725-kPa (250-psig) minimum]** [**2070 kPa (300 psig)**].

E. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 12.7-mm (1/2-inch) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

F. Thermal Sensitivity: Where permitted by NFPA 13, sprinklers shall be “quick-response”.

G. Sprinkler Finishes: Chrome plated, bronze, and white painted.

H. Special Coatings: Factory applied wax if required.

I. Sprinkler Types, Features, and Options as Follows:

1. Concealed ceiling sprinkler, including cover plate.
2. Extended-coverage sprinklers.
3. Pendent sprinklers.
4. Pendent, dry-type sprinklers.
5. Quick-response sprinklers.
6. Recessed sprinklers, including escutcheon.
7. Sidewall sprinklers.
8. Sidewall, dry-type sprinkler.
9. Upright sprinklers.
10. Early suppression/fast response sprinklers.

J. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, two piece, with 25-mm (1-inch) vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

K. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.10 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves DN50 (NSP 2) and Smaller: MSS SP-110, two-piece copper-alloy body with chrome-plated brass ball, 600-psig (4140 kPa) minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves DN50 (NPS 2) and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves DN50 (NPS 2) and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves DN50 (NSP 2) and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.11 HOSE CONNECTIONS

A. Nonadjustable-Valve Hose Connections:

1. Available Manufacturers:

   a. AFAC Inc.
   b. Central Sprinkler Corp
   c. Elkhart Brass Mfg. Co., Inc.
   d. Fire-End and Croker Corp.
   e. Fire Protection Products, Inc.
   f. GMR International Equipment Corp.
   g. Grinnell Fire Protection.
   h. Guardian Fire Equipment Inc.
   i. McWane, Inc.; Kennedy Valve Div.
   j. Mueller Company.
   k. Potter-Roemer; Fire-Protection Div.
   l. United Brass Works, Inc.

2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 2070 kPa (300 psig) minimum.
4. Material: Brass or bronze.
5. Size: DN 40 or DN 65 (NPS 1-1/2 or NPS 2-1/2), as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle.
9. Finish: Rough brass or bronze.

2.12 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type Fire-Department Connection

1. Available Manufacturers:

   a. AFAC Inc.

b. Central Sprinkler Corp.
c. Elkhart Brass Mfg. Co., Inc.
d. Fire-End and Croker Corp.
e. Fire Protection Products, Inc.
f. GMR International Equipment Corp.
g. Guardian Fire Equipment Inc.
h. Potter-Roemer: Fire-Protection Div.
i. Reliable Automatic Sprinkler Co., Inc.
j. United Brass Works, Inc.

2. Standard: UL 405.
3. Type: Exposed, projecting, for wall mounting.
4. Pressure Rating: 1200 kPa (175 psig) minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, wall type.
9. Outlet: Back, with pipe threads.
10. Number of Inlets: Provide one hose connection for each 946 L/min (250 gpm) of standpipe system demand.
11. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
12. Finish: Polished brass.
13. Outlet Size: [**DN 100 (NPS 4)**] [**DN 125 (NPS 5)**] [**DN 150 (NPS 6)**].

B. Flush-Type Fire-Department Connection

1. Available Manufacturers:

a. AFAC Inc.
b. Central Sprinkler Corp.
c. Elkhart Brass Mfg. Co., Inc.
d. Fire-End and Croker Corp.
e. Fire Protection Products, Inc.
f. GMR International Equipment Corp.
g. Guardian Fire Equipment Inc.
h. Potter-Roemer: Fire-Protection Div.
i. Reliable Automatic Sprinkler Co., Inc.
j. United Brass Works, Inc.

2. Standard: UL 405.
3. Type: Flush, for wall mounting.
4. Pressure Rating: 1200 kPa (175 psig) minimum.
5. Body Material: Corrosion-resistant metal.

6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Rectangular, brass, wall type.
9. Outlet: With pipe threads.
10. Body Style: **[Horizontal] [Square] [Vertical]**.
11. Number of Inlets: Provide one hose connection for each 946 L/min (250 gpm) of standpipe system demand.
12. Outlet Location: [**Back**] [**Bottom**] [**Left side**] [**Right side**] [**Top**].
13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
14. Finish: Polished brass.
15. Outlet Size: [**DN 100 (NPS 4)**] [**DN 125 (NPS 5)**] [**DN 150 (NPS 6)**] [**DN 200 (NPS 8)**].

C. Yard-Type Fire-Department Connection

1. Available Manufactures:

   a. AFAC Inc.
   b. Central Sprinkler Corp.
   c. Elkhart Brass Mfg. Co., Inc.
   d. Fire-End and Croker Corp.
   e. Fire Protection Products, Inc.
   f. GMR International Equipment Corp.
   g. Guardian Fire Equipment Inc.
   h. Potter-Roemer: Fire-Protection Div.
   i. Reliable Automatic Sprinkler Co., Inc.
   j. United Brass Works, Inc.

2. Standard: UL 405.
3. Type: Exposed, freestanding.
4. Pressure Rating: **[1200 kPa (175 psig) minimum] [2070 kPa (300 psig)]**.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Number of Inlets: Provide one hose connection for each 946 L/min (250 gpm) of standpipe system demand.
11. Sleeve: **[Brass] [Not required]**.
12. Sleeve Height: 460 mm (18 inches).
13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
14. Finish **[, Including Sleeve]: [Polished chrome plated] [Rough brass or bronze] [Rough chrome plated].**
15. Outlet Size: [**DN 100 (NPS 4)**] [**DN 125 (NPS 5)**] [**DN 150 (NPS 6)**].

2.13 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Available Manufacturers:

a. ADT Security Services, Inc.
b. Grinnell Fire Protection.
c. ITT McDonnell & Miller.
d. Potter Electric Signal Company.
e. System Sensor.
f. Watts industries, Inc,; Water Products Div.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals. Tamperproof cover that sends signal if removed is not permitted.
5. Type: Paddle operated.
6. Pressure Rating: 1725 kPa (250 psig).
7. Design Installation: Horizontal or vertical.

C. Pressure Switches:

1. Available Manufacturers:

a. Grinnell Fire Protection.
b. Potter Electric Signal Company
c. System Sensor.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:

1. Available Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

2. Standard: UL 753.
3. Type: Electrically supervised.

4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Tamperproof cover that sends signal if removed is not permitted.

E. Indicator-Post Supervisory Switch:

1. Available Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

2. Standard: UL 753.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Tamperproof cover that sends signal if removed is not permitted.

2.14 PRESSURE GAGES

A. Available Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.
3. U.S. Gauge.
4. Brecco Corporation
5. Dresser Equipment Group, Instrument Div.
6. Marsh Bellofram.
7. WIKA Instrument Corp.

B. Standard: UL 393.

C. Dial Size: 90- to 115-mm (3-1/2- to 4-1/2-inch) diameter.

D. Pressure Gage Range: 0- to 1725-kPa (0- to 250-psig) minimum.

E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Where system is to have water supplied from municipal water source, Contractor shall perform or witness fire-hydrant flow test according to NFPA 291. Use results for system design calculations required in "Quality Assurance" Article. Flow test shall be recent, and in accordance with NFPA 13 standards.

B. Where system is to have water supplied by compound fire pump, Contractor shall perform or witness fire pump flow test in accordance with NFPA 20. Use results for system design calculations required in “Quality Assurance” Article. Pump test shall be recent, and in accordance with NFPA 13 standards.

C. Report test results promptly and in writing.

3.2 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rate construction, frame for hose valve cabinets, and other conditions were hose connections and stations are to be installed.

C. Proceed with installation and only after unsatisfactory conditions have been corrected.

3.3 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to each building. Comply with requirements for exterior piping in Section 331414 "Fire Service Main and Appurtenances" for exterior piping. Service entrance to each building shall not be a trash room or hazardous area.

B. Install shutoff valve, pressure gage, drain, and other accessories indicated at connection to water-service piping. Install backflow preventer when connecting to a potable water supply. Do not install backflow preventer for systems supplied from fire protection water storage tank.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

D. Install an OS&Y shutoff valve immediately where service enters the building.

3.4 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section on domestic water piping.

B. Install shutoff valve, [**backflow preventer,**] pressure gage, drain, and other accessories indicated at connection to water-distribution piping.**[Comply with requirements for backflow preventers in Division 22 Section on domestic water piping specialties.]**

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.5 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 or NFPA 14.

   a. Shutoff: Use Butterfly or OS&Y valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are no required by NFPA 13 and NFPA 14

   a. Shutoff: Use ball, butterfly, or gate valves.
   b. Throttling: Use ball or globe valves.

3.6 PIPING INSTALLATION

A. Refer to **[Division XX]** Section for basic piping installations.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from OBO/OPS/FIRE/FPE. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

C. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

D. Underground piping: Install underground service-entrance piping in accordance with Section 331414 “Fire Service Main and Appurtenances” and NFPA 24.

E. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

F. Provide clearance or flexible couplings for all penetrations through all walls, floors, platforms, and foundations where required by NFPA 13.

G. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

H. Install unions adjacent to each valve in pipes DN 50 (NPS 2) and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

I. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.

J. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized according to NFPA 13. Test connection shall be installed at the most remote portion of the system. All test connection shall be permanently piped to drain outside the building. Drains must discharge to an approved splash block unless drains discharge directly to concrete or asphalt.

K. Install sprinkler piping with drains for complete system drainage to an approved location outside the building. Drains must discharge to an approved splash block unless drains discharge directly to concrete or asphalt.

L. All dry-pipe sprinkler system shall be pitched to drain regardless of if the space is conditioned per NFPA 13 requirements. Branch lines and mains shall be pitched at least 4mm/m (1/2 in. per 10 ft.).

M. All dry-pipe sprinkler system test connections and drains in conditioned or finished spaces shall be piped to exterior of buildings.

N. All dry-pipe sprinkler system test connections and drains shall be identified on dry pipe riser with permanent sign indicating number and location of each test connection or drain.

O. Drains shall not terminate to interior floor drains or janitor sinks.

P. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

Q. Install drain valves on standpipe and at all bulk isolation control valves.

R. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to outside building.

S. Install alarm devices in piping systems.

T. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to **[Division XX]** Section on vibration and seismic controls for fire-suppression piping and equipment.

U. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than DN 8 (NPS 1/4) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

V. Pressurize and check dry-pipe sprinkler system piping and [**air-pressure maintenance devices**] [**air compressors**].

W. Fill wet standpipe system piping with water.

X. Fill wet-pipe sprinkler system with water.

Y. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in **[Division XX]** Section on heat tracing for fire-suppression piping and for piping insulation in **[Division XX]** Section on fire-suppression systems insulation.

Z. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in **[Division XX]** Section on sleeves and sleeve seals for fire-suppression piping.

AA. Install sleeve seals for piping penetrations of concrete walls and slabs below grade. Comply with requirements for sleeve seals specified in **[Division XX]** Section on sleeves and sleeve seals for fire-suppression piping.

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in **[Division XX]** Section on escutcheons for fire-suppression piping.

3.7 JOINT CONSTRUCTION

A. Refer to **[Division XX]** Section for basic piping joint construction.

B. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

C. Install unions adjacent to each valve in pipes DN 50 (NPS 2) and smaller.

D. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.

E. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

F. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

G. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape to external pipe threads. Joint compound is not permitted.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
3. Pipe Thickness: Do not thread pipe smaller than DN200 (NPS 8) with wall thickness less than Schedule 40.
4. Test every 50 field-threaded joint with calibrated thread ring test gauge and document in log.

I. Twist-Locked Joints: Not permitted.

J. Steel-Piping, Pressure-Sealed Joints: Not permitted

K. Mechanical Tee fittings or Mechanical Crosses are not permitted unless approved by OBO/OPS/FIRE/FPE in writing.

1. Where permitted by OBO/OPS/FIRE/FPE in writing, coupon/cutout shall be permanently affixed to fitting.

L. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Field welding is not permitted. Do not use welded joints for galvanized-steel pipe.

M. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

N. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

O. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved end fittings and groove-end-pipe couplings.
2. Wet Steel Pipe: Cut- or roll-groove piping as indicated. Use groove end fittings and rigid grooved end-pipe couplings, unless otherwise indicated.
3. Dry Pipe Systems: Cut-groove piping only. Use groove end fittings and gaskets listed for dry-pie service.

P. Steel-Piping, Pressure-Sealed Joints: Not permitted.

Q. Dissimilar-Material Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Do not join dissimilar metals until all portions of all systems have been flushed.

1. DN50 (NPS 2) and Smaller: Use dielectric unions, couplings, or nipples.
2. DN65 to DN100 (NPS 2-1/2 to NPS4): Use dielectric flanges.
3. DN125 (NPS 5) and Larger: Use dielectric flange insulation kits.

3.8 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

3.9 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13, NFPA 14, and manufacturer’s recommendations.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install **[dry-pipe][and][deluge]** valves in vertical position, in proper direction of flow, and in main supply to system. Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

a. [Install air compressor and compressed-air-supply piping.]

b. **[Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with [95- to 410-kPa (14- to 60-psig)] <Insert value> adjustable range; and [1200-kPa (175-psig)] <Insert value> maximum inlet pressure.]**

3.10 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

D. Install sprinkler guards on all exposed sprinklers that are 2.3 m (7’-6”) or less above the finished floor elevation. Install sprinklers guards for all exposed sprinklers below duct work and any location subject to mechanical damage.

3.11 HOSE CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes.

B. Install freestanding hose connections for access and minimum passage restriction.

C. Hose connection shall be threaded match local fire departments hoses.

D. Provide DN65 by DN40 (NPS 2-1/2 by NPS 1-1/2) reducer adapter for all DN65 hose connections.

3.12 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type fire department connections in vertical wall.

B. Install freestanding-type, fire department connection in level surface.

C. Install protective pipe bollards on three sides of each fire department connection. Refer to Division 05 Section on metal fabrications for pipe bollards.

D. Install ball drip valve at each check valve for fire department connection. Drain to floor drain or outside building.

3.13 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13, NFPA 14, and in **[Division XX]** Section. In addition, labels shall be provided in the following locations:

1. Install near each valve and control device.
2. Provide labels at 12 m (40 ft) spacing on mains.
3. Provide labels at all access doors and shafts.
4. Provide labels at 6 m (20 ft) spacing on all branch lines.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section on identification for electrical systems.

3.14 FIELD QUALITY CONTROL

A. Periodic Inspections:

1. NICET Level III, NICET Level IV, or qualified Fire Protection Engineer shall perform inspection on the work performed as necessary to ensure quality control of the installation, but at intervals no greater than 60 days from previous inspection. Submit written inspection reports to OBO/OPS/FIRE/FPE for review.

B. Perform the following tests and inspections:

1. Air Tests: Prior to putting any water on the system, the contractor shall perform air pressure leakage tests at 40 psi for 24 hours for all piping and attached appurtenances. Any leakage that results in a loss of pressure shall be corrected and system retested. Testing shall occur prior to installing hard/non removable ceilings.
2. Hydrostatic Tests: After air testing has been witnessed and approved by OBO/OPS/FIRE/FPE, perform hydrostatic testing per NFPA 13. Any signs of leakage or a loss of pressure shall be corrected and system retested. Final hydrostatic testing shall be witnessed by OBO/OPS/FIRE/FPE. Testing shall occur prior to installing hard/non removable ceilings.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
5. Flush, test, and inspect standpipe system according to NFPA 14, "Systems Acceptance" Chapter.
6. Energize circuits to electrical equipment and devices.
7. Coordinate with fire-alarm tests. Operate as required.
8. Coordinate with fire-pump tests. Operate as required.

9. Verify that equipment hose threads are same as local fire department equipment.
10. OBO/OPS/FIRE may not be on site to witness flushing. If OBO/OPS/FIRE is unable to witness tests, the OBO site mechanical engineer must witness the tests and sign appropriate tests forms.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Installed pipe and fittings that appear out of ASME B1.20.1 specifications shall be confirmed with a thread ring test gauge and plug gauge.

E. Prepare test and inspection reports.

3.15 OBO/OPS/FIRE PROGRESS INSPECTIONS AND COMMISSIONING

A. OBO/OPS/FIRE personnel conduct routine on-site inspections of fire protection systems during construction. The normally conduct three progress inspections that occur at approximately 40-50 percent, 75 percent, and 90-100 percent construction completion stages of the overall project.

B. The contractor shall keep current on file all NFPA inspections required by cited NFPA standards, and test reports for use by OBO/OPS/FIRE/FPE personnel during these inspections.

C. All deficiencies given to the contractor shall be promptly remedied. Final acceptance of the system is contingent upon all noted deficiencies being corrected to the satisfaction of OBO/OPS/FIRE/FPE in addition to all required NFPA 13 testing.

D. Scheduling of final inspection is not permitted until the building(s) are substantially completed. The General Contractor shall schedule the final inspection in accordance with Division 01 requirements, and with minimum of 30 days in advance of requested date to allow for coordination by OBO/OPS/FIRE. Parameters for substantial completion is given in a separate document titled “Appendix E Final Testing/Acceptance Requirements for Fire and Life Safety Systems.”

1. When requesting the final inspection, the general contractor shall submit with the requested inspection date the completed affidavit titled “Fire and Life Safety Systems Request for Final Acceptance Test” signed and notarized as indicated on that form. The form is attached to this specification.

3.16 PAINTING

A. All valves shall be factory painted red.

B. Clean, pretreat, and prime all pipe and fittings. Paint sprinkler piping in non-architecturally sensitive areas (above suspended ceilings, warehouse, mechanical rooms, etc.) red. In architecturally sensitive areas, the piping color can either be painted red, or to match the color of adjacent surfaces.

3.17 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Only sprinklers and escutcheons with their original factory finish are acceptable. Remove and replace any sprinklers or escutcheons that are painted or have any other finish than their original factory finish.

C. Protect sprinklers from damage until Substantial Completion. Remove and replace any sprinkler observed to be damaged (torqued, bent, etc.).

D. Piping shall be protected prior to and after installation. No materials shall be stored outside without protection from the elements. Any pipe, fitting, valves, or other system component observed by OBO staff to be weathered shall be removed and discarded.

3.18 TRAINING

A. Training shall not be conducted until the sprinkler systems and fire pump have been tested in accordance with NFPA 13, 14, 20, and 72, and accepted by OBO/OPS/FIRE. Sprinkler system manufacturers' field representative shall provide two 8-hours day training sessions to Government personnel, including Foreign Service National maintenance personnel on location. Training shall include classroom and practical hands-on training covering operation, adjustments, theory, and troubleshooting. Specific operation maintenance manuals, as described in this section, shall be utilized for this training. Contractor shall video the training and produce a DVD deliverable such that future staff may benefit from the class.

3.19 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves shall be one of the following:

1. Stainless steel pipe with cut-grooved ends, stainless steel grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
2. Stainless steel pipe with stainless steel threaded fittings; and threaded joints

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet or dry-pipe sprinkler system, DN 50 (NPS 2) and smaller, shall be the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet or dry-pipe sprinkler system, DN 50 (NPS 2) and smaller within 5 feet of FEBR penetrations in buildings required to be seismically braced, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut-grooved ends; uncoated, flexible grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, DN 65 (NPS 2-1/2) and larger, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

F. Standard-pressure, dry-pipe sprinkler system, DN 65 (NPS 2-1/2) and larger, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.20 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Pendant, recessed, flush, and concealed sprinklers as indicated.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing:

   a. Upright: Pendant - dry sprinklers.
   b. Sidewall: Dry sprinklers as indicated.

B. Provide sprinkler types in subparagraphs below with factory applied finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

4. Residential Sprinklers: Dull chrome.
5. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211305

SECTION 213115 - FIRE PUMP ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies fire pumps, including but not limited to requirements for system components below:

1. Drive unit (diesel engine or electric motor).
2. Fire Pump.
3. Pump controllers.
4. Fuel tank.
5. Batteries with charger.
6. Flow meter.
7. Skid assembly.
8. Piping.
9. Electrical/electronic control wiring.

B. Fire Protection Water Storage Tank: See Drawings for individual water storage tank for dedicated fire protection purposes.

C. Related Sections: Comply with applicable requirements of other Sections which interface with related work of other Sections.

1. Division 01 Sections “Start-up and Commissioning” and “Demonstration and Training.”
2. Section 033000 “Cast-in-Place Concrete.”
3. Division 09 Sections on high performance coatings.
4. Division 09 Section on painting.
5. Section 105613 “Metal Storage Shelving” for lockable cabinet for spare parts.
6. Section 211305 “Fire Sprinkler System” for sprinkler installation, and for labeling, identification, and signage requirements.
7. Division 23 Section on building fuel oil piping.
8. Division 26 Sections for electrical provisions.
9. Section 284626 "Addressable Fire Alarm Systems.
10. Section 331414 “Fire Service Mains and Appurtenances” for compound distribution of fire protection water in relation to fire pump(s).
11. Section 335005 “Underground Fuel Storage Tanks and Distribution” for source of fuel used by fuel tanks (serving as fire pump day tanks) in this Section.

1.2 CODES AND STANDARDS

A. General: Comply with the following industry standards representing the latest edition applicable to the OBO criteria version applicable to the Project. These standards contain provisions which

are explicitly applicable to work of this Section, as well as other standards identified in this Section.

1. Codes: The OBO Building Code consists of the model International Building Code and OBO amendments in the OBO International Codes Supplements (OBO-ICS) to those model codes. Codes adopted by OBO are identified in Chapter 1 of the OBO-ICS IBC (supplement to the Building Code) for the year applicable to the project.
2. "Approval Guide" by Factory Mutual (FM).
3. "Fire Protection Equipment Directory" by Underwriters Laboratories, Inc. (UL).
4. Standards by the National Fire Protection Association (NFPA), including the following:

    a. NFPA 3, “Standard for Commissioning of Fire Protection and Life Safety Systems,” 2024 edition.
    b. NFPA 4, “Standard for Integrated Fire Protection and Life Safety System Testing,” 2024 edition.
    c. NFPA 13, “Standard for the Installation of Sprinkler Systems,” 2022 edition.
    d. NFPA 20, “Standard for the Installation of Stationary Pumps for Fire Protection,” 2022 edition.
    e. NFPA 22, “Standard for Water Tanks for Private Fire Protection,” 2023 edition.
    f. NFPA 24, “Standard for the Installation of Private Fire Service Mains and Their Appurtenances,” 2022 edition.
    g. NFPA 25, “Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,” 2023 edition.
    h. NFPA 37, “Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.” 2024 edition.
    i. NFPA 72, “National Fire Alarm and Signaling Code,” 2022 edition.

1.3 SUBMITTALS

A. Product Data: For each fire pump prefabricated assembly, submit product data to include, but not limited to, the following prepared information. Each submittal shall include two hard copies and one electronic copy on compact disk.

1. 200 mm x 250 mm (8" x 10") colored glossy photographs of each assembly from previously produced equivalent, if not identical assemblies. Digital pictures that meet this requirement are also acceptable.
2. Specific pump certified performance curves for each fire pump. Record head developed, pump efficiency, and brake horsepower required for full range of operation.
3. In addition to quantities required by Division 01 Section “Closeout Procedures,” submit two copies of printed product literature for each of the principal component and sub-components installed in the assembly covering recommended installation, testing, operation, maintenance, troubleshooting, special tools, service, spare parts, and similar user need-to-know information. Include base price lists and ordering information for all replaceable parts. Include approved copy of factory pump curve, and drafts of field operating instructions.

B. Shop Drawings: Show installation of each fire pump assembly with overall layout of service lines and assembly location at not less than 1:20 scale, fully dimensioned, with each principal element of unit indicated. Include marked plans, elevations, sequencing, and electrical/electronic wiring diagrammatically with circuit diagrams. Include separate plan of fabricated skid framing. Include list of all part numbers and weights for the entire pump assembly.

C. Hydraulic Calculations: Calculations indicating suction supply requirements, elevations, distance, fittings, pipe material, valves, static pressure, residual pressure, velocity, hydraulic reference points, and pump size. Approval for suction line installation will be denied until calculations are submitted. Failure to comply may result in excavation, and removal of installed suction piping at Contractor's expense.

D. Seismic Design Data: Pump manufacturer shall provide documentation that fire pump package, including all piping, day tank, controller and other equipment, has been analyzed to be designed and constructed to withstand an earthquake of force identified in the Article on QUALITY ASSURANCE. Manufacturer shall document that entire package will withstand earthquake according to seismic design requirements identified in Article on QUALITY ASSURANCE.

E. Exhaust Sizing (Diesel Engines): Exhaust back pressure calculations indicating the length of the exhaust piping, fittings, pipe sizes, and silencer make and model shall be provided. Calculations shall include that back pressure is within maximum allowable backpressure limits of the engine.

F. Factory Test Procedures: Submit pump manufacturer's test procedure for approval prior to testing.

G. Field Quality Control Test Data: Following installation of work in this Section, including field testing of fire pump assembly performances, submit field test report and certified statement of compliance with requirements signed by fire pump manufacturer’s representative and installing contractor. Include markup of each previously certified pump curve sheet, recording start-up field test data for the installation. Indicate performance compliances for each primary component of the assembly in field test reports and in certified compliance statements. Comply with Project Director/COR and/or OBO/OPS/FIRE requests.

H. Operation and Maintenance Manuals: After submitted quality control data has been accepted by OBO/OPS/FIRE, prepare and submit updated operation and maintenance manuals to OBO/OPS/FIRE through the Project Director/COR for every component of installed fire pump assemblies in titled/indexed loose-leaf binders. Include product data as specified in this Article, and all final adjustments/settings, and/or changes specific to contract installation upon completion and acceptance testing. Include complete spare parts listings, including price and source information for items specified in the Article on SPARE PARTS. Identify recommended spare parts inventory by manufacturer, as well as required spare parts inventory listed by OBO/OPS/FIRE in Article on SPARE PARTS, indicating stock/quantity listing for expendable items, and every component of fire pump assemblies for Government's inventory of replacement materials and parts. Manuals shall contain one laminated set each of abbreviated and emergency instruction information placards as posted on controller(s).

I. Warranties: Properly executed product warranties from manufacturer of principal components in assembly; both as required by these Specifications, and as noted to be available by published product literature.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer of fire pump assembly shall produce package system at their facility, and maintain ISO 9001 Quality Certification. Manufacturer must provide same-day, technical point of contact/response for inquiries by the Government from within United States and from OBO/OPS/FIRE personnel on tour of duty (TDY) around the world.

B. System Continuity: A single install shall be used for all aspects of installation, include both classified and unclassified work. Fire pump shall be installed by same contractor as installer of sprinkler system; see Section 211305 “Fire Sprinkler Systems.”

C. Manufacturer’s equipment, design, shop drawings and equipment submittals are required to be sourced from the United States.

D. Factory and field pump start-up shall be supervised by factory authorized technician(s). Technician(s) shall be certified on fire pump, driver and controller.

E. Provide permanent labels on components of equipment, recording approval stamps, recorded listings, recognized ratings, and other markings to show compliance with applicable standards by NFPA, UL, MSS, NEMA, and other trade associations.

F. Systems Testing: Manufacturer shall perform both factory testing and start-up/field testing of fire pump assembly operations in accordance with NFPA 20. Both tests are required to be witnessed by OBO/OPS/FIRE.

G. Seismic Design: Pump manufacturer shall design fire pump package, including all piping, day tank, controller and other equipment, according to the seismic design requirements in the Chapter 16 of the OBO Building Code. Brace and design package in accordance with requirements of NFPA 13 and NFPA 20. Rubber pads and springs with retaining clamps are not permitted to be used to secured skid base frame to housekeeping pad; this pertains to skinny skids, split skids, and full skid packages. Main electric/diesel driver and pump assembly shall not incorporate rubbers pads installed underneath legs or in mounting bases.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 “Cast-in-Place Concrete.”

1.6 DELIVERY, STORAGE, AND HANDLING

A. General: Fabricate structural steel skid unit, and assemble fire pump assembly components on skid unit with sufficient strength to withstand shipping and handling stresses as well as operational stresses. Equip skid unit with suitable hoisting "eyes", and similar devices for accommodation of hoisting slings and other handling methods. Handle assembled unit in compliance with manufacturers' instructions and recommendations for rigging and hoisting.

1. Preparation of Unit: After completion of factory test procedure for assembled unit, drain water and fuel from assembly, and dry entire unit. Treat bare steel/iron surfaces, internal and external, with rust-inhibiting coating of light oil or similar easily removed harmless substances. Package all assembly components for overseas shipment in manner that will exclude moisture intrusion and prevent corrosion of metal parts. Protect equipment, piping flanges, nozzles, and other openings or connections, and protect machines against intrusion of sand and other foreign matter. Plastic inserts/flange covers into the pipe ends is not acceptable; bolted wooden flange covers are acceptable.
2. Store and ship packaged/protected fire pump assemblies in clean, airtight, moisture resistant, durable shipping container, and retain in dry location at all times.

1.7 WARRANTY

A. Manufacturer’s Special Product warranty: Manufacturer of fire pump assemblies shall provide special product warranty for period of one year after the latter of substantial completion or final acceptance testing by manufacturers' representative, which is witnessed by OBO/OPS/FIRE. Warranty must be in writing, and be presented to the Project Director/COR upon final pump acceptance by Project Director/COR and OBO/OPS/FIRE.

1.8 EXTRA MATERIALS

A. Initial Spare Parts Stock: For each required fire pump assembly and controller with an initial stock of expendable items required for two years of service, specific maintenance materials, and spare parts identified below by OBO/OPS/FIRE. In addition, supplement that stock with recommended spare parts inventory by manufacturer; where the two lists are identical provide the larger of the quantities recommended. Include not less than the following categories/quantities of materials:

1. Stock:

   a. One complete engine and pump rebuild gasket set, gasket material, seals and O-rings; for diesel only.
   b. Two complete sets of engine filter and engine filter O-rings (in addition to O-rings in rebuild kits); for diesel only.
   c. 38 L (10 gallons) engine oil as recommended by engine manufacturer. One set of drive belts; for diesel only.

d. Two engine cooling loop solenoid drain valves.
e. Two complete sets of all fuses for fire pump and jockey pump controller.
f. Two 0-2500 KPa (0-300 psi) liquid filled gauges.
g. One each jockey pump pressure transducer and fire pump pressure transducer.
h. Fire pump controller I/O board.

2. Storage: Store spare parts inventory in separate, designated lockable storage cabinet specified in Section 105613 “Metal Storage Shelving;” this cabinet shall be attached to, or located adjacent to, fire pump assembly, which is located in fire pump room. Manufacturer shall determine size of cabinet necessary to store initial spare parts. Parts shall be individually labeled and packaged to resist environment in extended storage. Place laminated parts list, with corresponding manufacturers' part numbers as well as manufacturers' telephone and fax numbers and ordering information permanently attached inside of same cabinet. Fire pump package will not be accepted unless this requirement is complete.

1.9 MAINTENANCE AND OPERATION

A. General: Following completion of installation, start-up, field testing, and acceptance of fire pump assemblies on project site, and through remainder of project construction time, provide continued maintenance, and scheduled weekly automatic testing and/or emergency operational readiness of units; comply with instructions and recommendations of the manufacturer. Operate units weekly in accordance with NFPA 25.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Provide a United States sourced, skid-mounted, prefabricated, horizontally mounted fire pump assembly which is arranged and performs operationally in accordance with provisions of this Section, including each “Fire Pump Assembly Data Sheet.”

B. Maximum Output Pressure (Churn): Under no conditions, unless prior written approval by OBO/OPS/FIRE is obtained, shall the churn pressure of the fire pump measured at its output flange, be above 1200 kPA/sq. m (175 psi).

C. **[Low Speed Diesel: Diesel drivers shall be limited to a maximum of 2,400 RPM.]**

2.2 CENTRIFUGAL FIRE PUMPS

A. Description, General: UL 448, factory-assembled and -tested, **[diesel-][electric-]**drive, centrifugal fire pumps capable of furnishing not less than 150 percent of rated capacity at not

less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head.

1. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacities, characteristics, and other pertinent data.

B. Fabricate base and attachment to fire pumps, pressure-maintenance pumps, and controllers with reinforcement to resist movement of pumps and controllers during a seismic event when their bases are anchored to building structure. No “diamond” type or other metal plating shall be installed or welded onto top of skid frame during fabrication or field installation.

C. Single-Stage, Horizontally Mounted, Split-Case Fire Pumps: Single-suction type with pump and driver mounted on same base and connected with coupling.

1. Pump: Axially split cast-iron casing with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.

   a. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
   b. Wear Rings: Replaceable, bronze.
   c. Shaft and Sleeve: Steel shaft with bronze sleeve.

      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

2. Coupling: Flexible and capable of absorbing tensional vibration and shaft misalignment. Include metal coupling guard.
3. Driver: Diesel Engine or UL-listed, NEMA MG 1, open drip proof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.

D. Fire-Pump Characteristics and Specialty Data:

1. Fire-Pump Plan No.: **<Insert designation used on Drawings.>**

   a. Rated Capacity: **<Insert value – as required by fire sprinkler system demand.>**
   b. Churn Pressure: **<Insert value.>**
   c. Outlet Flange Class: 125.

2. Skid: No greater than 4450mm x 2300mm (175-inches x 90-inches).
3. Speed: Same as driver.
4. Churn pressure shall not exceed 1,200 kPa/sq. m (175 psi). Do not use high pressure pumps without written approval from OBO/OPS/FIRE through the Project Director/COR.
5. Maximum speed is 2,400 RPM.

2.3 FIRE PUMP CONTROLLERS

A. Fire-Pump Controllers, General: UL 218 and NFPA 20; listed for pump driver, fire-pump service and service entrance; combined automatic and manual operation; factory assembled and wired; and factory tested for capacities and electrical characteristics. Equip controller with capability/means to download event history onto easily removable media without use of laptop or serial port.

1. Rate controllers for scheduled fire-pump horsepower and short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.
2. Enclosure: UL 50, NEMA Type 4 (minimum), drip proof, indoor, unless special-purpose enclosure is indicated. Include manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
3. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed.

a. Isolating means and circuit breaker.
b. "Power on" indicating LED.
c. Visual and Audio Alarms: Provide the following:

1) Critically low oil pressure in lubrication system. Controller shall provide means for testing position of pressure switch contacts without causing trouble alarms.
2) High engine jacket coolant temperature.
3) Failure of engine to start automatically.
4) Shutdown from over speed.
5) Battery failure or missing battery. Provide each controller with separate visible indicator for each battery.
6) Battery Charger Failure: Provide each controller separate visible indicator for battery charger failure; they shall not require audible alarm for battery charger failure.
7) Low Fuel Level: Alarm at two-thirds tank capacity.
8) Switch not in automatic.
9) High/Low Fire Water Tank Level (two inputs).
10) Fuel spill.
11) Low Water Flow Alarm.
12) High water Temperature Alarm.
13) High Fuel Level Alarm: Alarm at 95 percent tank capacity.

d. Automatic and manual operation, with minimum run-time relay to prevent short cycling.
e. Water-pressure-actuated transducer responsive to water pressure in fire-suppression piping.
f. Automatic and manual shutdown.
g. System pressure recorder.
h. Remote alarms: Provide the following:

1) Engine is running (separate signal).
2) Controller main switch has been turned to off or manual position (separate signal).
3) Trouble on controller or engine.
4) Water Level Monitoring: Low water level in fire protection water supply tank.
5) Diesel Fuel Oil Tank Monitoring: Low fuel oil level in fire pump fuel oil storage tank.

4. Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.
5. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous metal sensing piping, NPS 1/2 (DN 15), with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32-inch (2.4-mm) orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32-inch (2.4-mm) orifice.

2.4 PRESSURE GAGES – OIL FILLED

A. Description: Oil-filled only permitted. 90 to 115 mm (3-1/2 to 4-1/2-inch) diameter dial. For gauge ranges, see Paragraph on “Suction and Discharge Gauges” in Article on COMPONENTS below. Include caption "WATER" on dial face.

2.5 COMPONENTS

A. Include the following, in addition to primary components (i.e., fire pump, drive unit, skid assembly, and internal-to-package piping and electrical/electronic control wiring as applicable for each unit as required):

1. Jockey Pump Relief Valve: Equip jockey pump with pressure relief valve on discharge side. Install pressure relief valves after discharge side of pump and before system check valve. It shall be UL listed and/or FM rated, and no smaller than 20 mm (3/4 inch). It shall be visibly piped to open floor drain so flow can be regulated and adjusted. Drain line shall be piped of non-corrosive material.
2. Air Relief Valve: Equip top of pump case with APCO automatic air vent valve.
3. Suction and Discharge Gauges: Provide suction and discharge gauges, Ashcroft Mfg., or approved equal with 90 mm (3-1/2 inch) dials on fire pump and having -100 to 250 KPa (−15 to 35 psi) suction and 0 to 2500 KPa (0-300 psi) discharge. Suction and pressure gauges shall be liquid filled and piped so they can be readily viewed by operator from fire pump controller. Gauges shall have brass ballcock to facilitate gauge maintenance. Adjust suction gauge rating if municipal bypass is provided.
4. Controller Sensing Line Gauge: Fire pump and jockey pump controller sensing lines shall have one each 0-2500 KPa (0-300 psi) liquid filled gauge, Ashcroft mfg. or approved equal, piped with brass ballcock 300 mm (12 inches) above the piping entrance to their respective enclosures.

5. Discharge Piping Drain Valve: Fire pump discharge piping shall have 25 mm (1 inch) drain valve with 25 mm (1 inch) plug, located at furthest point of fire pump manufacturers' discharge piping.
6. Drain Lines: Drains located on fire pump package (including, but not limited to, fire pump packing bowls, fire pump and jockey pump controller sensing line drains, and 25 mm (1 inch) drain line on furthest point of fire pump discharge piping) shall be piped to common 40 mm (1-1/2 inch) galvanized pipe header, piped to edge of skid, and ready for Contractor's piping to floor drain (except for fire pump packing bowls). Diesel engine heat exchanger piping shall be piped separately with its own sight glass and flex connector. Each drain branch line shall have union for maintenance, and shall be piped above level of properly grouted skid, and substantially supported. Galvanized piping from fire pump packing bowls shall be 20 mm or 25 mm (3/4 inch or 1 inch). All drain lines shall be of non-corrosive material.
7. Discharge Outlet and Suction Inlet: Provide tapered concentric increaser at discharge outlet and tapered eccentric reducer at suction inlet. Both shall be flanged or grooved with straight tapers; weld reducers/increasers are not acceptable.
8. Main Relief Valve Piping: Main relief valve, when diesel driven unit, shall begin operation at 1,200 kPa (175psi) and be piped back to reservoir unless otherwise approved by OBO/OPS/FIRE. If reservoir is potable water source, main relief shall be piped to alternative non-potable reservoir in accordance with the OBO Mechanical Code, or provide drain that is sized to accept full flow from main relief valve. Piping shall have sight glass of type with removable window. Relief valve discharge piping shall have check valve installed if piping is returned below expected reservoir water level. If trapped water is present, install 25 mm (1 inch) drain valve after relief valve and before check valve (to facilitate maintenance) on sight glass or relief valve. If 25-mm (1 inch) drain is installed, it shall be piped to common skid drain header. If pump drivers are electric, pipe typical 20-mm (3/4 inch) relief valve to drain header, and equip with sight glass.
9. Name Plates: Nameplates on fire pump skid package and components shall be permanent and legible throughout life of the equipment. If component name plates are not easily accessible, or subcontracted component labels of fire pump manufacturer are not of permanent stamped steel type, then fire pump skid package manufacturer shall construct permanent label and place it in conspicuous location near referenced equipment. If fire pump manufacturer utilizes "in-house" reference number, number shall appear on permanent metal placard, attached to skid in conspicuous location.
10. Flow Meter: Flow meter shall be Gerand Mfg. or approved equal.
11. Pump Valves: Provide OS&Y valve with SPDT tamper switch on suction side of pump. Provide butterfly valve equipped with SPDT tamper switch on discharge side of pump.
12. Check Valves: Provide wafer type check valve or swing check valves on discharge side of fire pump. All system control valves and system check valves must be UL listed and/or FM approved. They shall be rated not less than 1400 kPa (175 psi). Check valves shall have Rubber Faced Clapper Assemblies.
13. Fuel Tank: Fuel tank shall be double-wall with integral leak detection for space between walls, and with mechanism to drain sediment from tank bottom. Provide ball valve with locking feature and with design to maintain integrity against diesel fuel. Fuel capacity shall be in accordance with minimum NFPA 20 requirements. Provide High/Low fuel level switch.

14. Fuel Tank Water Separator: Provide fuel tank with water separator, in-line to diesel driver if provided integral to the driver.
15. Jockey Pump: Grundfos mfg. or equivalent.
16. Jockey Pump Controller: Jockey pump controller shall be programed to use minimum run timer.
17. Fire Pump Controller: Provide fire pump controller with minimum run timer. Controller shall be timed for self-starting weekly pump runs. Through Project Director/COR, contractor shall coordinate timing of weekly pump runs with Post Facility Manager for preferred time. Self-starting weekly pump runs shall not be programed for weekends. Only "manual" pressure switch test starts are allowed.
18. Batteries: Dual acid starting type; provide charger.
19. Tamper Resistance for Valves: All control valves controlling water supply to fire suppression system shall be tamper equipped/supervised.
20. Sensing Lines: Equip controller sensing lines with brass check valves, with 2.4 mm (3/32 inch) orifices or 2.4 mm (3/32 inch) restricting unions, installed per NFPA 20 guidelines for pressure switch protection against surges. All related piping for sensing lines shall be brass piping and no smaller than 15 mm (1/2 inch) in size.
21. Jockey Pump Piping: Equip jockey pump with brass suction strainer with clean-out. Suction side of jockey pump shall be tied-in before OS&Y valve on suction side of main fire pump. Pipe jockey pump discharge to system side of OS&Y valve.
22. Miscellaneous Assembly Requirements:

    a. Provide red factory finish for (virtually) entire assembly.
    b. Provide fire pump suction and discharge piping, flow meter return piping, heat exchanger discharge piping, combination drain header (at contractor's connection point), and pressure relief piping (for diesels), provided with flanged, braided, stainless steel type vibration isolation devices (grooved or flanged).
    c. Connect diesel exhaust piping to engine with flanged strain relief, rated for diesel exhaust use. Locate flanged, braided stainless steel vibration isolation devices between fire pump package and building piping.
    d. Firmly anchor piping, pressure sensing lines, by-pass with check valves (when applicable), shut-off valve drains, meters, controllers, and pumps to steel skid by means of structural steel supports.
    e. All electrical wiring between controllers, motors, and engine shall be completed and tested at factory. Entire package shall require just one power connection by electrical subcontractor. Connect fire pump, jockey pump and jockey pump controller, and all accessories/equipment which supports fire pump installation to essential bus.

B. Component Description: Design packaged fire pump system in accordance with requirements of NFPA 20. Fire pump shall be listed by Underwriters Laboratories and/or approved by Factory Mutual for fire pump services. Pump manufacturer shall assume unit responsibility for proper operation of entire system as specified herein.

1. Fire Pump Design: Fire pump basis of design is horizontal split case type and shall be U.L. listed and/or F.M. approved. The responsible fire protection subcontractor/designer shall identify: 1) RPM, 2) rotation, and 3) rated capacity in LPM (GPM) as dictated by sprinkler

demand calculations, and maximum churn pressure in KPa (psi). Pump shall deliver minimum of 150 percent of rated capacity at 65 percent of total rated head pressure. Fire pump shall be manufactured by Peerless, Fairbanks-Morse, Patterson, AC Fire, or approved equal.

2. Pump Drive Unit: Fire pump shall be driven by diesel engine or electric motor specifically listed by Underwriters Laboratories and approved by Factory Mutual for fire pump service. Engine horsepower shall be de-rated for elevation and temperature as required by NFPA 20. Engine shall have sufficient horsepower to operate fire pump under any condition of pump load. Engine shall be wired for 12 Volt operations. Maximum speed of driver is 2,400 RPM.
3. Diesel Engine Controller: Provide UL and FM approved automatic diesel engine controller by Metron Firetrol Mfg. or approved equal. House in National Electrical Manufacturers Association (NEMA) type 4 enclosure. Required voltage is (project specific) volts. Equip controller with means to electronically record event history, automatic starting; provide with minimum run timer, having minimum run time of ten minutes. Controller shall sense pressure on system by way of pressure transducer. Equip controller with digital, programmable time clock. Omit devices designed to stop pump in event of low suction pressure. Provide UL and FM approved automatic electric engine controller by Metron Firetrol Mfg., or approved equal, housed in NEMA type 4 enclosures.

4. [Electric Motor Controller: Fire pump controller shall have transfer switch suitable for available short-circuit at line terminals of controller, and transfer switch shall be marked "Suitable for use on a circuit capable of delivering not more than <insert value> amperes r.m.s. symmetrical at <insert value>." Controller shall provide automatic starting and be provided with minimum run timer having minimum run time of ten minutes. Controller shall sense pressure on system by way of pressure transducer. Controller shall be capable of signaling a remote panel of: AC Availability, AC Failure, Pump Operation, Loss of Phase, or Phase Reversal and low voltage. Phase reversal shall be alarmed through separate set of dry contacts. If reduced voltage is required, provide Wye Delta closed transition controller. If controller is equipped with selector switch, the switch shall be monitored.]

5. Jockey Pump Design: Jockey pump shall be manufactured by Grundfos Mfg. or approved equal. Provide installation with fusible disconnect. Equip pre-piped sensing lines with brass check valves with 2.4 mm (3/32 inch) orifices; restricted unions are not acceptable. Mount jockey pump controller in NEMA Type 4 minimum enclosure, with front mounted HAND-OFF-AUTO selector switch and overload relays. Provide jockey pump with emergency AC power circuit.

   a. For jockey pump, the responsible fire protection subcontractor/designer shall identify:

      1) Delivered LPM (GPM).
      2) Total dynamic head in kPa (psi).
      3) Operating HP, RPM, voltage, phase, and hertz.

   b. Sizing:

1) Volume: 40 LPM (10 GPM) maximum.
2) Churn Pressure (Maximum): 140 kPa (20 psi) maximum above fire pump churn.

6. Protection: Enclosures for controllers shall be NEMA type 4 minimum. **[Tropicalization is required via humidistat and a thermostat, wired in parallel to heater. Tropicalization devices shall be adjustable to protect controls from effects of humidity.]** Install equipment at factory by controller manufacturer.
7. Power Distribution: Provide power distribution system to accept incoming feeder and distribute power to the items below. Distribution shall have disconnect from main power supply. Each item referenced shall have independent breaker or approved disconnect, properly labeled with permanent signage. Enclosure shall be NEMA 4 rated.

   a. Engine controller.
   b. Engine jacket water heater.
   c. Jockey pump.

2.6 FACTORY TESTING

A. Factory Testing: Fire pump's initial commissioning shall be by manufacturer's licensed representative. Testing shall be in accordance with NFPA 20. The fire pump package shall be hydrostatically tested at factory at 1600 KPa (200psi) for two hours. Test system as a unit at manufacturer's facility prior to shipment. Energize system through power distribution system panel; all system failures shall be demonstrated. After successful completion of the hydrostatic test, conduct the NFPA 20 performance acceptance tests to include a flow test. Tests shall be witnessed and approved by OBO/OPS/FIRE, with notification of Project Director/COR. Refer to Article on SUBMITTALS for requirements prior to testing.

   1. Pump drive unit engine shall be tested prior to shipment from the manufacturer's factory. Provide test header, flow meter, and related components as required by NFPA 20.

PART 3 - EXECUTION

3.1 FIRE PUMP PACKAGE ASSEMBLY INSTALLATION

A. General: Comply with manufacturers' and OBO/OPS/FIRE instructions/recommendations for installation, alignment of equipment, and connected piping. Comply with industry standards identified in Part 1 of this Section. Support connected pipelines independently from support of fire pump components. Include flowmeter and heat exchanger discharge return lines to water source, unless otherwise approved by OBO/OPS/FIRE. Locate lines to avoid interfering with access to components for service and maintenance, including for removal of driver units, couplings, pump impellers, seals, and accessories. Proceed as follows:

1. Disconnect driver-to-pump couplings during setting, leveling, anchoring, and grouting of structural skid on foundation. Contractor shall assure qualified personnel perform this function correctly.
2. Support structural skid at required elevation on steel plate wedge shims at each anchor bolt location, nominally at 25 mm (1 inch) above concrete foundation. Adjust level of skid so that pump shaft and driver are level. Ensure coupling face and suction/discharge flanges are plumb when anchor bolts are nominally tightened.
3. Install forms at edges of foundation to retain grout, and to form edges of grout into a 25 mm (1 inch) chamfer.
4. Pour skid grout to depth of approximately 40 mm (1-1/2 inches), inside skid and strike to level of skid bottom for exposure outside skid. Ensure grout is substantially under skid frame members to inhibit voids under the skid. Allow initial pour to harden and cure.
5. Nominally retighten anchor bolt nuts and recheck level/plumb of main components.
6. Align pump and driver shafts and reconnect driver to pump couplings. Ensure with dial indicator, precision straight edge and taper gauge (if applicable), alignment is correct.
7. Fill skid frame to top flange with skid grout, allow hardening and curing. Tighten anchor bolts and nuts. Recheck pump/driver alignment, and correct as necessary, complying with manufacturer's recommendations. Repeat coupling alignment checks after making pipe connections.

B. Connections, General: Reinstall any components, connections, or accessories that might have been temporarily removed or disassembled for fire pump assembly installation. Exercise care to remove temporary fluids, coating and closures. Replace with operational fluids, coatings, and lubricants as specified by manufacturer. Proceed with final pipe sizes and connections as shown, with suction piping elevations and configurations fully complying with standards referenced in Part 1 of this Section and manufacturers' recommendations and OBO/OPS/FIRE direction. Keep pipe and equipment clean internally by use of plugs and temporary closure plates. Comply with applicable Divisions 21, 22 and 23 Sections for extension of pipelines to fire pump assemblies, and for connections thereto, including installation of flanges, unions, valves, and other pipeline devices indicated. Refer to Division 26 Sections for extension of electrical/electronic services to fire pump assemblies and for connections thereto for supplying power, controlling equipment, operating connecting alarms, devices, and other systems; these are not work of this Section, except as otherwise indicated.

1. Exhaust System: Fabricate engine exhaust piping as required to remove exhaust gas from pump room, and/or building. Connect flexible piping units to engine, and mount muffler units as indicated near shield/cage units to protect personnel from accidental contact and resulting burns. Install exhaust piping system with vibration dampeners and supported independently from fire pump assembly. Insulate extended piping system except where shown to be non-insulated; apply indicated thickness of exhaust piping insulation in compliance with insulation manufacturer's instructions and recommendations.
2. Welding: Comply with ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications" for qualification of welding processes and operators used in the fabrication of exhaust piping systems.

C. System Finishes, General: Refer to Division 09 section on "Painting" for cleaning/priming/painting exposed surfaces of any work of this section to include touch-up of

abraded factory finishes on fire pump assemblies, and extensions of red enamel finishes, and other finishes as indicated on connected service piping, conduits, and similar work not in this Section. The Project Director/COR will determine extent of specific paint color applications.

3.2 INSTALLATION AND INSTALLATION MATERIALS

A. Except as otherwise indicated, provide materials for completing connections for mechanical and electrical service lines to installed fire pump assemblies to match materials of those service lines, either as specified in other Sections hereof, or as existing on previously installed lines. This requirement is applicable to piping, conduit, wiring and other lines for materials, finishes, operational equipment and devices, including valves and switches.

1. Pump Foundation Materials: Comply with applicable provisions of Section 033000 "Cast-in-Place Concrete" for concrete and reinforcing materials as required to form/pour/reinforce, pump foundations as indicated; using 30 MPa (4000 psi) Portland cement mix. Comply with fire pump manufacturers' printed directions/recommendations for selection of materials.
2. Skid Grout: Provide non-shrinking and non-metallic grout mix, complying with ASTM 1107, Grade B, with design-mix strength of 35 MPa (5000 psi) for 28-day compression. Fill assembly level to top of skid without covering drain, power, control, or sensing line of any type.
3. Engine Exhaust Piping: ASTM A 53 Type E/S, Schedule 40 butt-welded black carbon pipe and fittings. Flange gaskets shall be non-asbestos, surface temperature rating of up to 1,100 deg C (2,000 deg F). Exhaust gasses shall not be discharged where they will affect persons, disrupt occupants, or endanger buildings.
4. Exhaust Piping Insulation: Insulation, reusable/removable thermal blankets; standard construction; high density 175 kg/cu. m (9 lbs/cu. ft.) flexible fibrous glass; standard 25 mm (1 inch) thick; silicone coated outer jacket, stainless steel mesh inner surface liner; stainless steel seaming materials; custom fitted for muffler, pipe fittings, and flanges located inside building; 550 deg C (1,000 deg F) operating temperature; installed with stainless steel lacing wire; Basis of Design is GT Exhaust Systems Series 100.
5. Exhaust Sound Suppression: Pump manufacturer shall provide muffler and flexible connection between engine and muffler. Engines exhausting from normally occupied buildings. Package shall utilize residential grade mufflers. Provide muffler inside of building. Install muffler horizontally and provide with vibration isolators.
6. Engine Exhaust Installation: Connect exhaust piping to engine with flanged, strain relief, rated for diesel exhaust use. Suspend exhaust piping by approved devices that allow limited movement of pipe to prevent stress cracks from developing. Piping that must pass through walls shall utilize steel sleeves, with minimum of 25 mm (1 inch) clearance. Fill exhaust piping-to-sleeve clearance with non-hardening, fireproofing.

    a. Roof/Wall Penetrations: Thimble, factory fabricated, aluminized steel with thermal insulation. Provide with rain guard when penetration is through exterior wall or roof. Basis of Design is GT Exhaust Systems Series 20.
    b. Rain cap (if roof discharge): Hinged, black steel with stainless bushing and hinge. Basis of Design is GT Exhaust Systems Series 22.

7. Heat Exchanger Discharge: Manufacturer of fire pump assembly shall provide stainless steel, flexible hose connection at discharge of heat exchanger for installing contractor to begin piping back to drain. Provide sight glass for heat exchanger discharge line with spring-loaded "ball" to indicate water flow. Heat exchanger discharge gauge shall be liquid filled, isolated from destructive engine vibration, and equipped with brass ballcock to facilitate maintenance. Return heat exchanger water to fire-protection water tank where reasonably feasible. Install temperature gauge on return line to tank.
8. Fuel Supply System: Provide fire pump engine fuel tank fill with operator-presence-control-switch and connect to facility fuel oil system. Coordinate with requirements in Division 23 Section on building fuel oil piping.
9. Water Tank Piping: All piping, fittings, hanger assemblies, vortex plats, and other components within tank shall be stainless steel. All piping and fittings from tank to fire pump suction control valve shall be stainless steel.

3.3 FIELD QUALITY CONTROL:

A. General: Perform each fire pump assembly installation, field start up, and field testing procedure under direct supervision, at project site, of manufacturer's authorized technical representative who is acceptable to OBO/OPS/FIRE. Record in writing, and deliver copy promptly to Project Director/COR, running record on each installation activity, with observed/measured/tested results of such activities. Begin and maintain fire pump logbook, starting with first operational test/date, including any faults, or corrections made. Logbook, or similar hard cover logbook with identical information, shall be left in controller for maintenance personnel to track weekly tests, problems, and maintenance performed. Logbook will be used to assist OBO/OPS/FIRE Technicians, and Fire Marshal inspections and tests. Advise Project Director/COR in advance of scheduled test times and provide OBO/OPS/FIRE a minimum of 30 days advance notice.

1. Piping Tests: Prior to proceeding with fire pump operating tests, complete hydrostatic tests to confirm watertight installation of pressurized piping systems at 1600 kPa (200 psi) for two hours. Test suction piping at minus one-half atmosphere to confirm absence of negative pressure (air) leakage into system during operation. A two-hour 1600 KPa (200 psi) hydrostatic test is also acceptable. Test shall be witnessed by Project Director/COR or their representative before any suction piping is covered in any manner. Failure to comply may result in excavation of the piping. Comply with applicable standards for hydrostatic testing. Document tests of all underground and above ground piping on "Contractors Material and Test Certificate for Aboveground Piping" and "Contractors Material and Test Certificate for Underground Piping".
2. Preparations for Equipment Start-up: Prior to field start-up of installed fire pump assemblies, check installations and make the following preparations comply with manufacturer's instructions and recommendations:

   a. Test and adjust controls and safeties. Pressure transducers shall be set with certified, liquid filled gauges. Pressure differentials shall be recorded in fire pump logbook.
   b. Check motor/engine for proper direction of rotation, and check pump impeller for unimpeded rotation.

c. Check engine coolant fluid level, and adjust to manufacturer's recommended anti-freeze mixture percentages, with minimum of 50 percent anti-freeze/water.
d. Ensure engine oil level is correct.
e. Verify all valves are in their normal position for testing fire pump.
f. Ensure pump casing is primed.
g. Adjust stuffing boxes/mechanical seals, and open supply lines.
h. Verify hot-start operation.

3. Assembly Field Tests: Promptly upon nominal completion of installation work, proceed with operating tests on fire pump assembly(s); comply with NFPA 20. Prior to starting of field acceptance testing, all diesel fire pumps shall be run continuously for a minimum of 60 minutes at 100 percent. Engine RPM and temperature shall be recorded at least every 15 minutes. Perform direct on-site operation and testing in coordination with manufacturer's representative. Comply with manufacturer's operating instruction, and demonstrate to Project Director/COR, OBO/OPS/FIRE, and the Government's operating personnel every operational feature and capability of installed equipment, including accessory elements which make up systems. All field start-up, testing, final acceptance, and commissioning of water reservoir, suction piping, and fire pump assembly shall be performed by installing contractor and pump manufacturer's representative in presence of OBO/OPS/FIRE personnel. The manufacturer’s representative shall complete "Pump Acceptance Test Data" form.

3.4 DEMONSTRATION

A. Training: Training shall not be conducted until fire pump installation, including fire alarm system monitoring, has been tested in accordance with NFPA 20 and 72, and accepted by OBO/OPS/FIRE. Pump manufacturers' field representative shall provide two 8-assembly and component training sessions to Government personnel, including Foreign Service National (FSN) maintenance personnel, on location. Training shall include classroom and practical hands-on training covering operation, adjustments, theory, and troubleshooting. Specific operation maintenance manuals, as described under Article on SUBMITTALS in paragraph on Operation and Maintenance Manuals, shall be utilized for this training. Contractor shall video the training and produce a DVD deliverable such that future staff may benefit from the class.

END OF SECTION 213115

SECTION 223230 – POTABLE WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes equipment, piping, and specialties, along with water testing and monitoring to provide potable water system.

B. Related Sections include the following:

1. Refer to Section 105613 “Metal Storage Shelving” for four-post metal storage shelving and for storage cabinets used for water treatment equipment and for storage of associated manuals and operational logbooks.
2. Refer to Division 12 Section for work bench and cabinets used for testing water and supplies.
3. Refer to Division 22 Section for general plumbing system requirements, including sink (required in Potable Water Treatment Room), meters and gages for plumbing piping for pressure gages, piping installation, fittings, specialties, and similar system components.
4. Refer to Division 22 or 23 Section for dielectric fittings.
5. Refer to Division 22 Section on Domestic Booster Pumps.
6. Refer to Section 230905 “Instrumentation and Controls for HVAC” for point list schedule related to Building Automation System (BAS) connection.
7. Refer to Division 26 Sections for installation of electrical connections for power, controls, and devices.
8. Refer to Section 331416 “Site Water Distribution.”

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME) Standards:

1. ASME Boiler and Pressure Vessel Code, BPVC-X-2023: "Fiber-Reinforced Plastic Pressure Vessels."

B. American Water Works Association (AWWA) Standards:

1. AWWA B100, “Granular Filter Material.”
2. AWWA B114, “Reverse Osmosis and Nanofiltration Systems for Water Treatment.”
3. AWWA B116, “Electrodialysis and Ion-Exchange Membrane Systems.”
4. AWWA B604, “Granular Activated Carbon.”
5. AWWA C652, “Disinfection of Water Storage Facilities.”
6. AWWA C653, “Disinfection of Water Treatment Plants.”

C. National Sanitary Foundation (NSF) Standards:

1. NSF/ANSI 14, “Plastics Piping System Components and Related Materials.”

2. NSF/ANSI 58, “Reverse Osmosis Drinking Water Treatment Systems.”
3. NSF/ANSI 60, “Drinking Water Treatment Chemicals - Health Effects."
4. NSF/ANSI/CAN 61, “Drinking Water System Components – Health Effects.”
5. NSF/ANSI 419, “Public Drinking Water Equipment Performance – Filtration.”

1.3 SYSTEM DESCRIPTION

A. Provide multi-barrier potable water system capable of providing the design volume and flow rate of water with minimum of operations and maintenance. Each treatment unit within the system must have parallel modules with isolation valves to allow each module to be isolated for maintenance while allowing second module to remain operating. As such, all maintenance should be capable of being accomplished without shutting down the treatment system. System must include the following treatment units:

1. Pretreatment: System must include at a minimum:

   a. Initial filtration.
   b. pH and corrosion monitoring.
   c. Langelier Saturation Index (LSI) monitoring and adjustment.
   d. Temperature monitoring.
   e. Turbidity monitoring.
   f. Total Dissolved Solids (TDS) monitoring.
   g. Alkalinity (HCO3-) monitoring.
   h. Hardness (Ca+2) monitoring.
   i. Disinfectant (Cl-) dosing and monitoring.

2. Raw water storage, including:

   a. Temperature monitoring.

   b. Mixing/stirring to eliminate dead zones and control horizontal and vertical thermal striation within +/- 2 degrees C.
   c. Disinfectant (Cl-) dosing and monitoring.

3. Secondary Filtration: Filtration with multimedia filters to **[XX]** micron.
4. Granular Activated Carbon (GAC) Filtration: GAC filters for removal of organics and Total Trihalomethane (TTHM) and Disinfection By-Products (DBP) contaminants.
5. Ion Exchange Media or Cartridge Filtration (if needed): For removal of site-specific inorganic contaminants.

6. [Reverse Osmosis: Use special care in disposing of reverse osmosis reject concentrate.]

7. [Tertiary Filtration: Filtration with sub-micron cartridge filters to remove cysts and spores.]

8. Potable Water Storage including:

   a. Continuous mixing/stirring.

b. Temperature monitoring and control to maintain temperature at 21 deg C/ 70 deg F or below).
c. Chlorine and pH monitoring and control.
d. Potable Water Storage Tank must be a split tank.

9. System monitoring of treatment unit flow rates and pressures, automated filter backwashing, and indication of other required maintenance.
10. System accessories including spill containment pallets for chemicals, OSHA Hazard Communications Standards (HAZCOM), and spill response kit with operating procedures.
11. Water quality testing and monitoring equipment necessary for daily testing with dedicated space and appropriate storage in the water treatment room to perform said tests.

B. Water treatment must conform to requirements of the OBO Plumbing Code OBO-ICS IPC Section 611. Disinfection must be based on use of **[sodium hypochlorite][calcium hypochlorite]** solutions.

C. Water treatment systems must be tailored to specific source water quality. However, in no case must untreated source water be conveyed directly to Department of State facilities served by system without written approval from Project Director/COR based on input from OBO/PDCS/DE mechanical engineer. Systems must be passive and self-correcting with chemical feed systems minimized to the extent practicable.

D. Provide automatic treatment capable of complying with National Primary and Secondary Drinking Water Regulations 40 CFR Parts 141 – 143 and Safe Drinking Water Act (PL 93-523, PL 104-182, and other applicable Public laws). Source water compliance testing must be conducted quarterly (three-month intervals) for one full year during construction to validate water treatment system design.

1.4 SUBMITTALS

A. Product Data: Include system design flow; component rated capacities; water pressure drops; shipping, installed, and operating weights; and furnished products listed below:

1. Pumps.
2. Chemical solution tanks with secondary containment.
3. Chemical mixers and feeders; Provide estimate of each chemical's daily and annual usage rates.
4. Process control monitoring equipment and devices.
5. Automated water quality testing and monitoring equipment and devices.
6. Process Treatment Units including filters and media: Provide calculations for each media backwash and replacement schedules based on average contaminant load from water quality test data.
7. Water Testing Kits for required manual water quality monitoring.
8. Storage tank mixers.

B. Certifications and Approvals:

1. NSF and AWWA certifications and approvals as applicable.

2. Approvals by local Authority Having Jurisdiction or Host Country authorities if required.

C. Shop Drawings: Detail equipment assemblies and piping indicating dimensions, weights, loads, required housekeeping pads and clearances, and location and size of field connections. Shop drawings must include all components, locations of monitoring/sampling ports (both before and after treatment), valves, gauges, vibration isolators and seismic isolators and appurtenances. NSF approvals and method of field assembly must also be provided. Indicate access to floor drains and wall hydrants.

D. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.

E. Design Test Data, Calculations, and Analysis of supply water source(s) as required in Chapter 6 of the OBO-ICS IPC. Submit six final copies of report and analyses to Project Director/COR for distribution to the following: OBO/CFSM/CM (for their records), Commissioning Agent, OBO/OPS/FAC, OBO/OPS/SHEM, Post Facility Manager, and OBO/PDCS/DE mechanical engineer. Indicate and interpret test results for compliance with performance requirements. At a minimum, testing must be done by ISO 70125 accredited laboratory and include national primary drinking regulated contaminants as well as those defined as secondary water standards. In addition to regulated parameters, testing for corrosivity, sediment particles count, and size distribution analysis is also required.

F. Water treatment and environmental expert must prepare Narratives, Calculations, and associated equipment selections. Include design flows and pressures, and life-cycle costing with estimates of equipment life and labor for treatment system process (e.g., filter cartridges, media, sodium hypochlorite or other disinfectant, corrosion and pH control chemicals, etc.) and equipment selection. Calculation must be provided for each process that demonstrate sufficient contact and residence time for expected maximum contaminant concentration removal to safe levels. Provide calculations demonstrating adequacy of disinfection system including locations of feed points.

G. Operations and maintenance manuals for supplied equipment including information on normal operating parameters, when to change consumable parts, and troubleshooting guide.

H. Complete list of required NSF 61 approved filters/media, chemicals including testing reagents, disinfection agents, and cleaning chemicals. Identify local source and/or foreign source and shipping restrictions.

I. Compliance Monitoring Program: Provide quality control manual and testing schedule for process control and treatment compliance including constituents to be removed by the treatment processes. At a minimum, include testing schedules for turbidity, E. coli, Langelier Saturation Index (LSI), and chlorine residual.

J. Installation completion report including required test data as described in the execution section, adjustments and initial set-points, backwash water volumes, total and per process, and either filter run times or initial and final pressure drops.

1.5 QUALITY ASSURANCE

A. Process Monitoring: At a minimum, the parameters listed below must be monitored. Monitoring equipment must be designed for use in the water treatment system.

1. Flow rate, instantaneous.
2. Flow rate, total.
3. Operating pressures.
4. Pressure differential (across all filters).
5. Turbidity (raw and finished water).
6. Chlorine Residual, pH, TDS, alkalinity, hardness, and temperature in the raw and potable tanks and at the booster pump skid.

B. Piping materials must bear label, stamp, or other markings of specified testing agency.

C. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for the intended use.

D. NSF Compliance:

1. Comply with NSF 14, “Plastics Piping System Components and Related Materials” for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
2. Comply with NSF 58, “Reverse Osmosis Drinking Water Treatment Systems” (if applicable).
3. Comply with NSF 60, “Drinking Water Treatment Chemicals - Health Effects."
4. Comply with NSF 61 “Drinking Water System Components – Health Effects” for materials for water-service piping and specialties for domestic water.

E. Conform to applicable local or Host Country codes and regulations where provisions are more stringent than cited U.S. standards. Ensure that all necessary reviews and approvals are obtained from local or Host Country officials.

F. Implement applicable provisions of the Quality Control program as established in Division 01 Section "Contractor’s Quality Control."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship and store water treatment components in accordance with manufacturer’s recommendations.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving other occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Project Director/COR not less than two weeks in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Project Director/COR's written permission.

1.8 COORDINATION

A. Water service to the building must be coordinated with Site Utility Plans to comply with OBO-ICS-IZC 813.

1.9 EXTRA MATERIALS

A. Provide minimum of one year of water treatment chemicals (e.g., disinfectant, pH and corrosion control, etc.) and other consumables (e.g., filter media, cartridges, bag filters, etc.) that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.10 MAINTENANCE SERVICE

A. Commencing at the contract’s Substantial Completion date for a period of one calendar year, provide system maintenance service based on manufacturer's recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. In addition to the initial year of maintenance service, provide a proposal for a renewable option year. The option year proposal must be submitted 60 days prior to the end of the initial maintenance contract period.

B. Maintenance service must be inclusive of troubleshooting, adjusting, operating, laboratory testing, testing for the complete operation, filtration and softening equipment, chemical feeding, storage tanks, booster and recirculation pumps, and control panels, using factory-trained service personnel.

C. Maintenance service must include preventive maintenance, repair or replacement of worn or defective components, required supply of chemicals, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks must also align with the manufacturer's recommended checklists as required in Division 01 Section 017825 "Systems Manual and O&M Data." Provide completed maintenance records inclusive of scheduling to the USG for inclusion in the CMMS.

PART 2 - PRODUCTS

2.1 WATER TREATMENT SYSTEM

A. Pretreatment:

1. Initial filtration:

a. Filters: <**[XXX]** micron bag filters.
b. Two complete filtration units must be provided each able to filter 100 percent of the required volume with one filtration unit out of service.

2. Disinfection: Disinfect raw water with sodium hypochlorite and maintain a free chlorine residual of 0.2 – 0.5 ppm in the raw water storage tank.
3. LSI monitoring and adjustment: 0.01<LSI<0.30.
4. Water Softeners:

a. Conform to AWWA B116.
b. Softener system must be twin alternating.
c. Each softener tank must be sized for 100 percent of the system flow rate.
d. The system must be sized for a maximum of one regeneration per day.
e. Regeneration calculations and flow rates must be provided.
f. Refer to Division 22 Section on Commercial Domestic Water Softeners.

B. Raw Water Storage Processes:

1. Disinfection: Disinfect raw water with sodium hypochlorite and maintain a free chlorine residual of 0.2 – 0.5 ppm in the raw water storage tank.
2. Recirculation pumps must be installed and sized to turn over the water in the storage tank every 6 hours unless mixer with venting is deemed appropriate – then optimize both for homogenization of disinfectant residual.

3. Mixing: Raw water tank must be mixed/stirred **[with ventilation]** to eliminate dead zones and control horizontal and vertical thermal striation within +/- 2 degrees C.

C. Potable Water Treatment:

1. A complete filtration system must operate with parallel treatment modules with each parallel module able to treat 100 percent of required daily volume demand.

2. Stage 1: Multimedia filtration.

a. Multimedia Particulate Filtration – **[XX]** micron:

1) Conform to AWWA B100 and B116.
2) Each tank must be capable of processing 100 percent of flow rate.
3) Loading must not exceed 12 $m^3/hr/m^2$ (5 gpm/ft^2).

b. Install isolation valves on inlet and outlet of each filter housing.
c. Install pressure gauges on common inlet and outlet header of each of filter housings. Install flowmeters on outlet header.

3. Stage 2: Ion Exchange Modules.

a. Conform to AWWA B116.
b. Install isolation valves on inlet and outlet of each filter housing.
c. Install pressure gauges on common inlet and outlet header of each of filter housings. Install flow show meters on outlet header.

4. Stage 3: Granulated Activated Carbon (GAC) Filtration:

a. Conform to AWWA B604.

b. **[50 percent coconut and 50 percent coal-based charcoal on 12/40 sieve][XX].** Minimum bed depth 900 mm.
c. Maximum 12.0 $m^3/hr/m^3$ (1.5 gpm/ft^3) flow rate. Empty Bed Contact Time (EBCT) must be calculated for the contaminant(s) being removed.
d. Provide two filters; each filter must be sized for 100 percent of system flow rate.
e. Filters must automatically backwash sequentially.
f. Install isolation valves on inlet and outlet of each filter housing.
g. Install pressure gauges on common inlet and outlet header of each of filter housings. Install flow meters on outlet header.

5. Stage 4: Final Cartridge Filtration:

a. Conform to NSF/ANSI 419.

b. Cartridge filters must include, as necessary, a 3-stage system with a **[XX]** micron, followed by **[X]** micron, followed by 1 micron absolute.
c. Install cartridge filter housings in parallel. Each housing must be capable of treating 100 percent of the system flow rate.
d. Stainless steel filter housings.
e. Install isolation valves on inlet and outlet of each filter housing.
f. Install pressure gauges common inlet and outlet header of each of the filter housings. Install flow meters on the outlet headers.

6. Stage 5: Disinfection: Liquid or tablet chlorination, or on-site generation, such that the system maintains a free chlorine residual in all parts of the distribution system between 0.2 – 0.5 mg/l (ppm). Where sodium hypochlorite is selected, equipment must be able to provide adequate disinfection using between 4 and 12.5 percent solution.

D. Potable Water Storage Processes:

1. Disinfection: Disinfect potable water with sodium hypochlorite and maintain a free chlorine residual of 0.2 – 0.5 ppm in the potable water storage tank.
2. Recirculation Pumps: Pumps must be installed and sized to turn over the water in the storage tank every 6 hours.

3. Temperature Monitoring: Potable water storage temperatures must be monitored and reported to BAS.

E. Process Pressure FRP Tanks (if required for water treatment):

1. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels."
2. Pressure Rating: 690 kPa minimum.
3. Wetted Components: Suitable for water temperatures from 5 to at least 49 deg C.
4. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
5. Support Legs or Skirt: Constructed of structural steel, or similar material, bonded to tank before testing and labeling.
6. Coating: Protective coating to prevent corrosion.

F. Controls: Fully automatic; factory mounted on unit and factory wired.

1. Push-button start and complete manual or automatic operation.
2. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration or backwash at any hour of day and any day of week or at fixed time and flow intervals.
3. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
4. Main Operating Valves: Industrial, automatic, multiport, full-port ball valves with the following features:

   a. Slow opening and closing, non-slam operation.
   b. Isolated dissimilar metals within valve.
   c. Valves must be NSF 61 certified.

5. Flow Control: Automatic flow control to control backwash and flush rates over wide variations in operating pressures. Automatic flow control must not require field adjustment.
6. Battery Backup: Provide UPS for electronic control systems such that power flashes and losses will not interrupt equipment operation.

G. Factory-Installed Accessories:

1. All accessories must be NSF 61 certified.
2. Piping, valves, tubing, and drains.
3. Sampling cocks.
4. Main-operating-valve position indicators.
5. Water Meters.

H. Water Distribution and Circulation Pumps:

1. See Division 22 Specification for triplex distribution pumps, booster pumps, recirculation pumps, and hydropneumatic tank requirements. Refer to Division 22 Section on Domestic Water Pumps.

I. [Reverse Osmosis Units:

1. Construction: In accordance with AWWA B114.

a. Provide two complete systems, each able to produce 100 percent of required volume.
b. Design system for automatic operation with minimal operator intervention.]

J. Chlorine Dosing Pumps:

1. Chlorine (Sodium Hypochlorite) feed pumps must be peristaltic or diaphragm type pumps designed specifically for purpose of chemical dosing.
2. Utilize chlorine analyzer to monitor chlorine residual in tank; it must signal chlorine feed pump to dose at rate sufficient to maintain residual of 0.2 – 0.5 ppm Cl_2. Chlorine Analyzers must utilize disposable probes (Chemtrac HydroACT or equivalent).

2.2 MONITORING AND TESTING EQUIPMENT

A. Provide complete filter testing, monitoring equipment, and incubator at location in facility identified in the Construction Documents.

1. Basis of Design: Hourly, daily, weekly water quality and compliance testing must include manual (in addition to BAS) recording: each treatment system module and pumps - flow rates, leak check, and pressures (minimum three times per day); chemical treatment flow rates, leak checks, and chemical storage tank levels (daily); water quality monitoring - manually monitor/record storage tanks daily for pH, chlorine level, turbidity, and temperature; water quality monitor/record specific contaminants of concern.
2. E. coli, total coliforms test kits must conform to one of the following:

a. Colisure.
b. Colilert.
c. Colitag.

B. Provide additional equipment, reagent, and record storage as necessary to fulfill the requirements of the monitoring plan prepared above.

C. Utility Sink and Benchtop: Provide sink and adjacent benchtop space in Potable Water Equipment Room to facilitate field water quality testing. Refer to Section 224215 “Commercial Plumbing Fixtures” for Utility Sink requirements.

D. BAS Interface: Provide a communication Interface for monitoring by the BAS.

1. The communication Interface must be ASHRAE 135 BACNET/IP protocol ready for integration into the BAS.
2. At minimum, the communication Interface must provide water treatment parameters to the BAS as listed within section 230905 Point List Schedule.
3. Potable Water Treatment manufacturer/vendor is responsible for coordinating this requirement with the BAS contractor to ensure proper interfacing.

4. Potable Water Treatment manufacturer/vendor must provide all required onsite technical support to demonstrate proper transfer of information between water treatment system and BAS.
5. Potable Water Treatment system must have no component/device with wireless (to include Wi-Fi) communication capability.

2.3 WATER PIPE, FITTINGS, AND JOINTS

A. Applies only to cold water pipe, fittings, and joints within water treatment room to address corrosive environment and connection points to water treatment equipment. Plastic piping must not be used for hot water.

B. Pipe: CPVC, Schedule 80. ASTM D2846/D2846M (Sch 80) or ASTM F441/F441M or ASTM F442/F442M (SDR-PR) or CSA B137.6.

C. Fittings: CPVC, Schedule 80, ASSE 1061 or ASTM D2846/D2846M or ASTM F437 or ASTM F439 (Sch 80) or CSA B137.6.

D. Joints: CPVC solvent cement ASTM F493.

PART 3 - EXECUTION

3.1 WATER TREATMENT EQUIPMENT INSTALLATION

A. Install water treatment equipment on concrete bases, level and plumb, according to manufacturer's written instructions, layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances but not less than one (1) meter clearance around treatment unit skids. Arrange units so controls and devices requiring service are accessible.

B. In accordance with requirements in Chapter 16 of the IBC, install seismic restraints for tanks and floor-mounting accessories and anchor to substrate.

C. Install pressure gages on all process inlet and outlets.

3.2 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Install drains as indirect wastes to spill into open drains or over floor drains. Size floor drains, trench drains, or drain pits to accommodate 200 percent of the calculated backwash flow rates to prevent flooding water treatment room floor.

C. For equipment grounding, tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Make piping connections to dissimilar-metal water piping with dielectric fittings. Refer to Division 22 or 23 Section for dielectric fittings.

E. CPVC solvent cement must be used to connect CPVC pipe to equipment with PVC pipe outlets / inlets. PVC solvent cement must not be used to connect to CPVC pipe.

F. Restrictions on Configuration of Connections and Associated Components:

1. Installation of sanitary drains, storm drains, hydronic piping, fuel piping, hazardous chemicals or associated pumps or equipment directly above raw, potable, or fire water tanks is not permitted.
2. Distribution piping of any system running above the tank, through the tank, or under the tank is not permitted.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field assembly of components and installation of water treatment equipment, including piping and electrical connections. Report results in writing.

1. Contamination: Keep equipment, pipes, and fittings enclosed or capped to prevent/eliminate system contamination, debris, and obstructions during startup.
2. Leak Tests: After installation, charge system modules at twice the operating pressures and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Clean and disinfect Water Storage Facilities and Water Treatment Plants as follows:

1. Disinfection of water storage tank(s) are required before putting into service per AWWA C652.
2. Disinfection of raw water storage tank(s) are required before putting into service.
3. Disinfection of Water Treatment Plants is required before putting into service per AWWA C653.

C. Sample water treatment plant effluent after startup and at three consecutive seven-day intervals (total of four samples). Prepare certified test reports for required water performance characteristics based on the initial water tests and the constituents the plant is intended to remove. As a minimum, the testing must include microbiologicals, chlorine residual, turbidity, and LSI (temperature, pH, TDS, alkalinity, and hardness) for corrosivity.

D. Contractor project-warranty manager must implement the compliance monitoring plan for the duration of the warranty period and submit monthly reports.

3.4 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain units.

1. Schedule training with Project Director/COR with at least 14 days advance notice.
2. Train Government's maintenance personnel on procedures and schedules related to start-up, normal operation, shutdown, manual operation, controls set-up and programming, and alarms for maintaining potable water treatment in coordination with complete domestic water system. Provide review of control drawings and schematics. Demonstrate interactions with other systems.
3. Review data in maintenance manuals.

4. [Reverse Osmosis: Review procedures for disposing of reverse osmosis reject concentrate and provide training on membrane cleaning and maintenance.]

B. Training must be comprised of two training sessions as follows:

1. Classroom: 8 hours minimum
2. Field Demonstration: Field Demonstration: 16 hours minimum

END OF SECTION 223230

SECTION 224105 - RESIDENTIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes plumbing fixtures and related components for residential buildings, such as Staff Diplomatic Apartments (SDA) and Marine Security Guard Quarters (MSGR), and for representational residences (REP) such as Chief of Mission Residence, Deputy Chief of Mission Residence, and Consular General Residence. In addition, this Section includes those fixtures and components for private executive bathrooms in office buildings.

B. Related Sections include the following:

1. **[Division 10 Section on prefabricated shower receptor and door for individual showers, including testing of floors and receptors for water tightness.]**
2. Section 113103 “Residential Appliances.”
3. Division 22 Section on drinking fountains and water coolers.
4. Section 224215 “Commercial Plumbing Fixtures” for fixtures not in this section.
5. Division 22 Section on plumbing specialties for backflow preventers and specialty fixtures not in this section.

1.2 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.3 SUBMITTALS

A. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, electrical characteristics, and flow-control rates.

1. Identify WaterSense label where applicable.

B. Wiring diagrams from manufacturer for electrically operated units, including for power, signal, and controls as applicable.

C. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals specified in Division 01.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, prior to obtaining similar products from other manufacturers specified for that category, submit findings to Project Director/COR that a single manufacturer is not available for that category (identify specific fixtures exceptions), and secure concurrence from Project Director/COR for obtaining similar products from other manufacturers specified for that category

B. If procured outside U.S., fixtures shall meet equivalent standard for performance and flow, as approved by Project Director/COR based on documentation provided to OBO/PDCS/DE mechanical engineer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Project Director/COR, and marked for intended use.

D. Regulatory Requirements: Comply with accessibility requirements in Architectural Barriers Act (ABA) as identified in Chapter 11 of the OBO Building Code.

E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Finishes for fixtures within same rooms shall match.

I. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Hand Sinks: NSF 2 construction.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
5. Vitreous-China Fixtures: ASME A112.19.2.
6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

J. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3.
3. Faucet Hose: ASTM D 3901.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Supply and Drain Fittings: ASME A112.18.1.
11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

K. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3.
2. Automatic Compensating Valves for Individual Showers and Tub: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Backflow Prevention Devices for Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445; limit maximum setting to 49 deg C (120 deg F).
6. Hose-Coupling Threads: ASME B1.20.7.
7. Pipe Threads: ASME B1.20.1.
8. Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations: ASSE 1016.
9. Standard Consumer Safety Specification for Scald-Preventing Devices and Systems in Bathing Area: ASTM F444

L. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1.

M. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.6.3.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Off-Floor Fixture Supports: ASME A112.6.1M.
6. Pipe Threads: ASME B1.20.1.
7. Plastic Toilet Seats: ANSI Z124.5.

8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 EXTRA MATERIALS

A. Furnish the following to Project Director/COR at project closeout:

1. Faucet Washers and O-Rings: 10 percent of each type.
2. Faucet Cartridge and O-Rings: 10 percent.
3. Flushometer-Tank Repair Kits: 5 percent of fixtures.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. General: All faucets and water closets shall be water conserving; provide manual devices unless specified or indicate otherwise for specific fixture type.

2.2 LAVATORY FAUCETS

A. Manual Lavatory Single-Control Faucet - SDA, MSGR-Private-Bathrooms: Single-control mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 3.0 L/min.
2. Body Material: Cast brass or copper or brass underbody with brass cover plate.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Mounting: Deck, exposed
5. Valve Handle(s): Lever.
6. Inlet(s): DN 15 male shank.
7. Spout: **[Rigid type][Rigid, gooseneck]**.
8. Spout Outlet: Aerator.
9. Operation: Compression, manual.
10. Drain: Pop-up activation; DN 32.
11. Tempering Device: Adjustable hot limit safety stop.
12. Labeling: WaterSense.

B. Manual Lavatory Single-Control Faucet, Accessible – SDA-Accessible, MSGR-Public-Bathroom, REP: Single-control mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 3.0 L/min.
2. Body Material: Cast brass or copper or brass underbody with brass cover plate.

3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Mounting: Deck, exposed
5. Valve Handle(s): Compliant with accessibility requirements of ABA.
6. Inlet(s): DN 15 male shank.
7. Spout: **[Rigid type][Rigid, gooseneck]**.
8. Spout Outlet: Aerator.
9. Operation: Compression, manual.
10. Drain: Grid type with DN 32 offset tailpiece.
11. Tempering Device: Adjustable hot limit safety stop.
12. Labeling: WaterSense.

C. **[XXX Lavatory Faucet, Accessible – Office-Executive-Bathroom: XXX**

1. Maximum Flow Rate: XXX
2. Body Material: XXX
3. Finish: XXX
4. Centers: XXX
5. Mounting: Deck, exposed.
6. Valve Handle(s): Compliant with accessibility requirements of ABA.
7. Inlet(s): DN 15 male shank.
8. Spout: XXX
9. Spout Outlet: XXX
10. Operation: XXX
11. Drain: Grid type with DN 32 offset tailpiece
12. Tempering Device: Adjustable hot limit safety stop.
13. Labeling: WaterSense.]

D. Sensor Lavatory Faucet – SDA-Public-Area: Coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 1.9 L/min.
2. Body Material: Cast brass or copper or brass underbody with brass cover plate.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Mounting: Deck, exposed.
5. Inlet(s): DN 15 male shank.
6. Spout: Rigid type.
7. Spout Outlet: Aerator.
8. Operation: Sensor.
9. Drain: Pop up; DN 32.
10. Tempering Device: Adjustable hot limit safety stop.
11. Labeling: WaterSense.

E. Sensor Lavatory Faucet, Accessible – MSGR-Public-Bathroom, SDA-Public-Area: Coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 1.9 L/min.
2. Body Material: Cast brass or copper or brass underbody with brass cover plate.

3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR].**
4. Mounting: Deck, exposed.
5. Inlet(s): DN 15 male shank.
6. Spout: Rigid type**.**
7. Spout Outlet: Aerator.
8. Operation: Sensor.
9. Drain: Grid type with DN32 offset tailpiece.
10. Tempering Device: Adjustable hot limit safety stop.
11. Labeling: WaterSense.

2.3 SHOWER FAUCETS

A. Shower Faucet - SDA, MSGR. Include hot- and cold-water indicators. Coordinate faucet inlets with supplies and outlet with wall supply.

1. Maximum Flow Rate: 6.7 L/min., unless otherwise indicated.
2. Body Material: Cast brass.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Type: Single-handle thermostatic and pressure balance valve, with provision to limit setting so that it does not exceed 49 deg C (120 deg F).
5. Mounting: Exposed.
6. Handles: Lever.
7. Operation: Compression, manual.
8. Antiscald Device: Integral with mixing valve.
9. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
10. Supply Connections: DN 15 female inlet, DN 15 male outlet.
11. Shower Head Material: Metallic with chrome-plated finish.
12. Head Type: Ball joint.
13. Spray Pattern: Adjustable.
14. Integral Volume Control: Required.
15. Shower-Arm, Flow-Control Fitting:
16. Labeling: WaterSense.

B. Shower Faucet, Accessible – SDA-Accessible, REP. Include hot- and cold-water indicators; soft hand-shower, hose, wall supply, and slide bar. Coordinate faucet inlets with supplies and outlet with wall supply.

1. Maximum Flow Rate: 6.7 L/min.
2. Body Material: Cast brass.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR].**
4. Type: Single-handle thermostatic and pressure balance valve, provision to limit setting so that it does not exceed 49 deg C (120 deg F).
5. Mounting: Exposed.

6. Handles: Lever.
7. Backflow Protection Device for Hand-Held Shower: Required.
8. Operation: Compression, manual, conforming to ABA.
9. Antiscald Device: Integral with mixing valve.
10. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
11. Supply Connections: DN 15 female inlet, DN 15 male outlet.
12. Shower Head Material: Metallic with chrome-plated finish.
13. Head Type: Handheld, slide-bar mounted.
14. Spray Pattern: Adjustable.
15. Integral Volume Control: Required.
16. Hose: 1525mm minimum.
17. Labeling: WaterSense.

C. **[Shower Faucet, Accessible – Office-Executive-Bathroom: XXX. Include hot- and cold-water indicators; soft hand-shower, hose, wall supply, and slide bar. Coordinate faucet inlets with supplies and outlet with wall supply.**

1. Maximum Flow Rate: XXX
2. Body Material: XXX
3. Finish: XXX
4. Type: Single-handle thermostatic and pressure balance valve, provision to limit setting so that it does not exceed 49 deg C (120 deg F).
5. Mounting: XXX
6. Handles: Lever.
7. Backflow Protection Device for Hand-Held Shower: Required.
8. Operation: Compression, manual, conforming to ABA.
9. Antiscald Device: Integral with mixing valve.
10. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
11. Supply Connections: DN 15 female inlet, DN 15 male outlet.
12. Shower Head Material: XXX
13. Spray Pattern: Adjustable.
14. Integral Volume Control: Required.
15. Hose: 1525mm minimum.
16. Labeling: WaterSense.]

2.4 BATHTUB/SHOWER FAUCETS

A. Bathtub/Shower Faucet - SDA: Include hot- and cold-water indicators; check stops; tub spout; and shower head, arm, and flange. Coordinate faucet inlets with supplies; coordinate outlet with diverter valve.

1. Body Material: Cast Brass.
2. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR].**
3. Type: Single-handle thermostatic/pressure-balance valve for bathtub and for shower, provision to limit setting so that it does not exceed 49 deg C (120 deg F).
4. Maximum Flow Rate: 9.5 L/min.
5. Diverter Valve: Integral with mixing valve.
6. Mounting: Concealed/exposed wall.
7. Bathtub Spout: Chrome-plated brass**[with diverter]**.
8. Operation: Compression, manual.
9. Antiscald Device: Integral with mixing valve.
10. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
11. Supply Connections: DN 15.
12. Shower Head Type: Ball joint with arm and flange.
13. Shower Head Material: Metallic with finish to match.
14. Spray Pattern: Adjustable.
15. Integral Volume Control: Required.
16. Shower-Arm Flow-Control Fitting:
17. Showerhead Labeling: WaterSense.

B. Bathtub/Shower Faucet, Accessible – SDA-Accessible, REP: Include hot- and cold-water indicators; check stops; tub spout; and shower head, arm, and flange. Coordinate faucet inlets with supplies; coordinate outlet with diverter valve.

1. Body Material: Cast Brass.
2. Finish: Polished chrome plate.
3. Type: Single-handle thermostatic/pressure-balance valve for bathtub and for shower, provision to limit setting so that it does not exceed 49 deg C (120 deg F).
4. Maximum Flow Rate: 9.5 L/min.
5. Diverter Valve: Integral with mixing valve.
6. Mounting: Concealed/exposed wall.
7. Bathtub Spout: Chrome-plated brass**[with diverter]**.
8. Operation: Compression, manual, conforming to ABA.
9. Antiscald Device: Integral with mixing valve.
10. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
11. Supply Connections: DN 15.
12. Backflow Protection Device for Hand-Held Shower: Required.
13. Shower Head Type: Handheld, slide-bar mounted.
14. Shower Head Material: Metallic with finish to match.
15. Spray Pattern: Adjustable.
16. Integral Volume Control: Required.
17. Shower-Arm Flow-Control Fitting:
18. Hose: 1525 mm minimum.
19. Showerhead Labeling: WaterSense.

2.5 SINK FAUCETS

A. Kitchen Sink Faucet - MSGR, SDA: Kitchen faucet with pull-down spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes, and outlet with spout and fixture receptor.

1. Maximum Flow Rate: 6.7 L/min., unless otherwise indicated.
2. Body Material: Cast brass.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Mixing Valve: Single lever-activated, washerless cartridges.
5. Backflow Protection Device for Hose Outlet: Required.
6. Centers: Adjustable.
7. Mounting: Deck, exposed.
8. Handles: Single metal lever.
9. Inlets: DN 15 male shank.
10. Spout: Swing, shaped tube.
11. Spout Outlet: Aerator.
12. Vacuum Breaker: Required.
13. Operation: Compression, manual.
14. Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.

B. Kitchen Sink Faucet, Accessible – SDA-Accessible**,** REP-Family-Kitchen: Kitchen faucet with pull-down spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Maximum Flow Rate: 6.7 L/min., unless otherwise indicated.
2. Body Material: Cast brass.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Mixing Valve: Single lever-activated, washerless cartridges.
5. Backflow Protection Device for Hose Outlet: Required.
6. Centers: Adjustable.
7. Mounting: Deck, exposed.
8. Handles: Single metal lever, Compliant with accessibility requirements of ABA.
9. Inlets: DN 15 male shank.
10. Spout: Swing, shaped tube.
11. Spout Outlet: Aerator.
12. Vacuum Breaker: Required.
13. Operation: Compression, manual, conforming to ABA.
14. Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.

C. Sink Faucet – MSGR Pantry (at Recreation Room), REP Bar: Bar-type, centerset sink faucet. Include hot- and cold- water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Body Material: Cast brass.
2. Maximum Flow Rate: 6.7 L/min

3. Finish: **[Polished chrome plate] [Brushed chrome if approved by Project Director/COR]**.
4. Centers: 102 mm.
5. Mounting: Deck, exposed.
6. Handles: Brass levers.
7. Inlet: DN 15 male shank.
8. Spout: Brass gooseneck swing spout.
9. Vacuum Breaker: Required.
10. Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.
11. Spout Outlet: Aerator.

D. Laundry and Utility Sink Faucet - MSGR, REP, SDA: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Body Material: Cast brass.
2. Maximum Flow Rate: 6.7 L/min., unless otherwise indicated.
3. Finish: Polished chrome plate.
4. Mixing Valve: Two-lever handle.
5. Backflow Protection Device for Hose Outlet: Required.
6. Centers: 102mm
7. Mounting: [**Deck, exposed] [Back/wall, exposed]**.
8. Handles: Knob.
9. Inlets: DN 15 male threaded inlet shanks.
10. Spout: Swing, solid brass
11. Spout Outlet: Hose thread.
12. Vacuum Breaker: Required.
13. Operation: Compression, manual.
14. Drain: Grid.

E. Service Sink Faucet - MSGR, REP, SDA-Building-Janitor's-Closet: Service sink faucet with stops in shanks, vacuum breaker, hose thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Body Material: Cast brass.
2. Finish: Polished chrome plate.
3. Mixing Valve: Two-lever handle.
4. Backflow Protection Device for Hose Outlet: Required.
5. Centers: Adjustable, 152 to 254mm with offset shanks.
6. Mounting: **[Deck, exposed] [Back, wall, exposed]**.
7. Handles: Knob.
8. Inlets: DN 15 male shank.
9. Spout: Rigid, solid brass with wall brace with bucket hook.
10. Spout Outlet: Hose thread
11. Vacuum Breaker: Required.
12. Operation: Compression, manual.
13. Drain: Grid.

F. **[Kitchenette Sink Faucet – SDA-TDY: Kitchen faucet with no spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.**

1. **Maximum Flow Rate: 6.7 L/min., unless otherwise indicated.**
2. **Body Material: Cast brass.**
3. **Finish: Polished chrome plate.**
4. **Mixing Valve: Single lever-activated, washerless cartridge.**
5. **Centers: 203mm adjustable.**
6. **Mounting: Deck, exposed.**
7. **Handle: Single, metal lever.**
8. **Inlets: DN 15 male shank.**
9. **Spout: 200mm tubular swing.**
10. **Spout Outlet: Aerator.**
11. **Vacuum Breaker: Required.**
12. **Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.]**

G. **[Kitchenette Sink Faucet, Accessible – Accessible-SDA-TDY: Kitchen faucet with no spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.**

1. **Maximum Flow Rate: 6.7 L/min., unless otherwise indicated.**
2. **Body Material: Cast brass.**
3. **Finish: Polished chrome plate.**
4. **Mixing Valve: Single lever-activated, washerless cartridge.**
5. **Centers: 203mm adjustable.**
6. **Mounting: Deck, exposed.**
7. **Handle: Single, metal lever, conforming to ABA.**
8. **Inlets: DN 15 male shank.**
9. **Spout: 200mm tubular swing.**
10. **Spout Outlet: Aerator.**
11. **Vacuum Breaker: Required.**
12. **Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.]**

2.6 TOILET SEATS

A. Toilet Seat – SDA-Dwelling-Units: Solid plastic.

1. Configuration: Closed front with cover.
2. Size: Regular.
3. Class: Residential.
4. Hinge Type: SS, self-sustaining.
5. Color: White.

B. Toilet Seat – MSGR-Private-Bathrooms, SDA-Public-Area: Solid plastic.

1. Configuration: Closed front with cover.

2. Size: Regular.
3. Class: Commercial (standard).
4. Hinge Type: SS, self-sustaining.
5. Color: White.

C. Toilet Seat, Accessible – SDA-Accessible-Dwelling-Units, REP, Office-Executive-Bathroom: Solid plastic.

1. Configuration: Open front without cover.
2. Size: Elongated.
3. Class: Residential.
4. Hinge Type: SS, self-sustaining.
5. Color: White.

D. Toilet Seat, Accessible – SDA—Accessible-Public-Area, MSGR-Public-Bathrooms: Solid plastic.

1. Configuration: Open front without cover.
2. Size: Elongated.
3. Class: Commercial (standard).
4. Hinge Type: SS, self-sustaining.
5. Color: White.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Enclosure - MSGR, REP, SDA, Office-Executive-Bathroom: High-impact, stain resistant vinyl enclosure, specifically manufactured for enclosing hot- and cold-water supplies, trap and drain piping, electronic faucet connections, and mixing valves under wall hung lavatories complying with accessibility requirements of ABA.

B. Protective Shielding Pipe Covers - MSGR, REP, SDA: Molded, closed-cell anti-microbial vinyl seamless P-trap insulation kit furnished with seamless riser tubes, supply angle stop covers, seamless drain tailpiece cover, and angle stop wheel handle covers. Comply with accessibility requirements of ABA.

2.8 FIXTURE SUPPORTS

A. Water-Closet Support - MSGR, REP, SDA: Water-closet combination carrier designed for accessible and standard mounting height. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Lavatory Support - MSGR, REP, SDA: Lavatory carrier with concealed arms and tie rod. Include steel uprights with feet.

1. Accessible Fixture Support: Include rectangular steel uprights.

2.9 DISPOSERS

A. General: For pairs of sinks, provide in shallowest bowl if bowls are of different depths.

B. Disposer - MSGR-Kitchen: Batch-feed, household, food-waste disposer. Include 220-VAC, **[50Hz][60 Hz]**, 3/4 hp motor with overload protection and reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; DN 40 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

C. Disposer – SDA, MSGR-Heritage-Room: Batch-feed, household, food-waste disposer. Include 220-VAC, **[50Hz][60 Hz]**, ½ hp motor with overload protection and reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; DN 40 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

D. Disposer, Accessible – SDA-Accessible, REP-Family-Kitchen: Batch-feed, household, food-waste disposer. Include 220-VAC, **[50Hz][60 Hz]**, ½ hp motor with overload protection and reset button; accessible wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; DN 40 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

2.10 WATER CLOSETS

A. Water Closets – SDA, MSGR-Private-Bathrooms: Floor-mounting, floor outlet vitreous-china fixture designed for gravity-type tank operation.

1. Style: Close coupled.

   a. Bowl Type: Round front with siphon-jet design. Include bolt caps matching fixture.
   b. Height: Standard.
   c. Tank: Gravity type with trim. Include cover.
   d. Trip Mechanism: Lever-handle actuator.
   e. Color: White.

2. Supply: DN 15 chrome-plated brass or copper with loose-key stop.
3. Toilet Seat: As specified for MSGR, SDA.
4. Labeling: WaterSense.

B. Water Closets, Accessible – SDA-Accessible, MSGR-Public-Bathroom, REP, Office-Executive-Bathroom: floor-mounting, floor-outlet, and vitreous-china fixture designed for gravity-type tank operation.

1. Style: Close coupled.

   a. Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
   b. Height: Accessible.
   c. Design Consumption: 4.8 L/flush
   d. Tank: Gravity type with trim. Include cover.

e. Trip Mechanism: Lever-handle actuator.
f. Color: White.

2. Supply: DN 15 chrome-plated brass or copper with loose-key stop.
3. Toilet Seat: As specified for MSGR, SDA, REP.
4. Labeling: WaterSense.

C. **[Water Closets – SDA, MSGR-Private-Bathrooms: Dual-flush, floor-mounting, floor-outlet, and vitreous-china fixture designed for gravity-type tank operation.**

1. Style: Close coupled.

a. Bowl Type: Round front with siphon-jet design. Include bolt caps matching fixture.
b. Height: Standard.
c. Design Consumption: Dual flush 4.8 L/flush average volume.
d. Tank: Gravity type with trim. Include cover.
e. Trip Mechanism: Push two-button actuator.
f. Color: White.

2. Supply: DN 15 chrome-plated brass or copper with loose-key stop.
3. Toilet Seat: As specified for MSGR, SDA.
4. Labeling: WaterSense.]

D. **[Water Closets, Accessible – SDA-Accessible, MSGR-Public-Bathroom, REP: Dual-flush, floor-mounting, floor-outlet, and vitreous-china fixture designed for gravity-type tank operation.**

1. Style: Close coupled.

a. Bowl Type: Elongated front with siphon-jet design. Include bolt caps matching fixture.
b. Height: Accessible.
c. Design Consumption: Dual flush 4.8 L/flush average volume.
d. Tank: Gravity type with trim. Include cover.
e. Trip Mechanism: Push two-button actuator.
f. Color: White.

2. Supply: DN 15 chrome-plated brass or copper with loose-key stop.
3. Toilet Seat: As specified for MSGR, SDA, REP.
4. Labeling: WaterSense.]

2.11 LAVATORIES

A. Lavatories – SDA, MSGR-Private-Bathrooms: Counter-mounting, vitreous-china fixture.

1. Type: Self-rimming.
2. Oval Lavatory Size: 508 by 432 mm.

3. Faucet Hole Punching: Three, 102-mm centers, holes.
4. Faucet Hole Location: Top.
5. Color: White.
6. Faucet: Lavatory. As specified for MSGR, SDA.
7. Supplies: DN 10 chrome-plated copper with stops.
8. Drain: See faucet.
9. Drain Piping: DN 32 chrome-plated cast-brass "p" trap; DN 40 thick tubular brass waste to wall; and wall escutcheon.

B. Lavatories, Accessible – SDA-Accessible, MSGR-Public-Bathroom, REP: Wall-hanging, vitreous-china fixture.

1. Type: With contoured back.
2. Size: 508 by 432 mm rectangular.
3. Faucet Hole Punching: Three, 102-mm centers holes.
4. Faucet Hole Location: Top.
5. Color: White.
6. Faucet: As specified for accessible MSGR, REP, SDA.
7. Supplies: DN 10 chrome-plated copper with stops.
8. Drain: See faucet.
9. Drain Piping: DN 32 by DN 40 chrome-plated cast-brass "p" trap; DN 40 thick tubular brass waste to wall; and wall escutcheon.
10. Protective Shielding Guard: As specified for MSGR, REP, SDA.
11. Fixture Support: Lavatory, as specified for MSGR, REP, SDA.

C. **[Lavatories, Accessible – Office-Executive-Bathrooms: XXX**

1. Type: XXX
2. Size: XXX
3. Faucet: XXX
4. Faucet Hole Location: Top.
5. Color: XXX
6. Faucet: As specified for accessible Office Executive Bathroom.
7. Supplies: DN 10 chrome-plated copper with stops.
8. Drain: See faucet.
9. Drain Piping: DN 32 by DN 40 chrome-plated cast-brass "p" trap; DN 40 thick tubular brass waste to wall; and wall escutcheon.
10. Protective Shielding Guard: As specified for Office Executive Bathroom.
11. Fixture Support, XXX]

2.12 BATHTUBS

A. Bathtubs - SDA: PMMA (acrylic plastic) fixture.

1. Bathing Surface: Slip resistant according to ASTM F462.
2. Standard: ANSI Z124.1.2.
3. Size: 1525 by 765 mm with front apron.

4. Color: White.
5. Drain Location: **[Left] [Right]** end.
6. Faucet: As specified for SDA.
7. Supplies: DN 15 copper tubing with ball, gate, or globe valves.
8. Drain: DN 40; chrome-plated exposed parts; brass pop-up waste and overflow.
9. Drain Piping: DN 40 cast-brass "p" trap and waste.
10. Tub filler.

B. Bathtubs, Accessible – SDA-Accessible: PMMA (acrylic plastic) fixture.

1. Bathing Surface: Slip resistant according to ASTM F462.
2. Standard: ANSI Z124.1.2.
3. Size: 1525 by 765 mm with front apron.
4. Color: White.
5. Drain Location: **[Left][Right]** end.
6. Accessibility Options: Include grab bar and bench.
7. Faucet: As specified for accessible SDA.
8. Supplies: DN 15 copper tubing with ball, gate, or globe valves.
9. Drain: DN 40; chrome-plated exposed parts; brass pop-up waste and overflow.
10. Drain Piping: DN 40 cast-brass "p" trap and waste.
11. Tub filler.

C. Bathtubs, Accessible – REP: Enameled cast-iron or enameled steel fixture.

1. Bathing Surface: Slip resistant according to ASTM F462.
2. Standard: ASME A112.19.1/CSA B45.2.
3. Size: 1680 by 765 mm with front apron.
4. Color: White.
5. Drain Location: **[Left][Right]** end.
6. Accessibility Options: Include grab bar and bench.
7. Faucet: As specified for accessible REP.
8. Supplies: DN 15 copper tubing with ball, gate, or globe valves.
9. Drain: DN 40; chrome-plated exposed parts; brass pop-up waste and overflow.
10. Drain Piping: DN 40 cast-brass "p" trap and waste.
11. Tub filler.

2.13 SINKS

A. **[Kitchenette Sink – SDA-TDY: Counter-mounting, self-rimming, Type 304, 18-8 stainless steel sink.**

1. Overall Size: 559 by 432 mm.
2. Number of Compartments: One.
3. Bowl Depth: 165 mm.
4. Sink Faucet: As specified for SDA.
5. Supplies: DN 15 chrome-plated copper with stops.
6. Mounting Holes: As required by selected sink faucet.

7. Drain Opening: 89 mm, off-center - 114mm from back, outlet for disposer.
8. Drain: See faucet.
9. Drain Piping: DN 40 chrome-plated cast-brass "p" trap, 1.1-mm- thick tubular brass waste to wall, continuous waste, and wall escutcheons.
10. Disposer: As specified for SDA.
11. Underside: Fully coated to dampen sound and prevent condensation.]

B. **[Kitchenette Sink, Accessible - SDA-TDY-Accessible: Counter-mounting, self-rimming, Type 304, 18-8 stainless steel sink.**

1. Overall Size: 559 by 432 mm.
2. Number of Compartments: One.
3. Bowl Depth: 165 mm.
4. Sink Faucet: As specified for SDA.
5. Supplies: DN 15 chrome-plated copper with stops.
6. Mounting Holes: As required by selected sink faucet.
7. Drain Opening: 89 mm, off-center – 114 mm from back, outlet for disposer.
8. Drain: See faucet.
9. Drain Piping: DN 40 chrome-plated cast-brass "p" trap, 1.1-mm- thick tubular brass waste to wall, continuous waste, and wall escutcheons.
10. Disposer: As specified for SDA.
11. Protective Shielding Guard: As specified for SDA.
12. Underside: Fully coated to dampen sound and prevent condensation.]

C. Kitchen Sinks - SDA: Counter-mounting, stainless-steel fixture.

1. Overall Size: 1067 by 533 mm.
2. Number of Compartments: Two.
3. First Compartment: With 89-mm outlet for disposer.
4. First Compartment Location: Left.
5. Second Compartment: Located on opposite side of first compartment; with 89-mm crumb cup.
6. Sink Faucet: As specified for SDA.
7. Supplies: DN 15 chrome-plated copper with stops.
8. Drain Piping: DN 40 chrome-plated cast-brass "p" trap, 1.1-mm- thick tubular brass waste to wall, continuous waste, and wall escutcheons.
9. Disposer: As specified for SDA.
10. Underside: Fully coated to dampen sound and prevent condensation.

D. Kitchen Sinks, Accessible – SDA-Accessible, REP-Family-Kitchen: Counter-mounting, stainless-steel fixture.

1. Overall Size: 1067 by 533 mm.
2. Number of Compartments: Two.
3. First Compartment: With 89-mm outlet for disposer.
4. First Compartment Location: Left.
5. Second Compartment: Located on opposite side of first compartment; with 89-mm crumb cup.

6. Sink Faucet: As specified for accessible SDA**[, REP]**.
7. Supplies: DN 15 chrome-plated copper with stops.
8. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1-mm- thick tubular brass waste to wall, continuous waste, and wall escutcheons.
9. Disposer: As specified for accessible SDA**[, REP]**.
10. Protective Shielding Guard: As specified for SDA**[, REP]**.
11. Underside: Fully coated to dampen sound and prevent condensation.

E. Kitchen Sinks - MSGR: Separate pair in adjacent cabinets, undermount, stainless-steel fixture, non-accessible.

1. Basis of Design:

   a. Left Sink: Elkay ELUH2816.
   b. Righ Sink: Elkay ELUH281610.

2. Left Sink: Min. 710-mm x 405-mm, x 175- mm deep (28” x 16” x 7-12/”), with 89-mm outlet for disposer.
3. Right Sink: Min. 710-mm long by 405- mm wide by 250-mm deep (28” x 16” x 10”), with 89-mm crumb cup.
4. Sink Faucets: As specified for MSGR.
5. Installation Profile: 13-mm reveal.
6. Supplies: DN 15 chrome-plated copper with stops.
7. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1-mm- thick tubular brass waste to wall, continuous waste, and wall escutcheons.
8. Disposer: As specified for MSGR for left sink.
9. Underside: Fully coated to dampen sound and prevent condensation.
10. Accessories, One Set: Cutting board, rinsing basket, utensil caddy for rinsing basket.

F. Sinks – MSGR Heritage Room, REP Bar: Single-compartment, counter-mounting, stainless-steel bar-type fixture.

1. Size: 432 by 508 mm.
2. Sink Faucet: Bar-type, as specified for MSGR, REP.
3. Supplies: DN 15 chrome-plated copper with stops.
4. Drain: see faucet.
5. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1-mm- thick tubular brass waste to wall, and wall escutcheon.
6. Underside: Fully coated to dampen sound and prevent condensation.

2.14 DISHWASHER AIR-GAP FITTINGS

A. Fittings:

1. Standard: ASSE 1021.
2. Description: Device designed to prevent backflow of contaminated liquid into domestic dishwashers.
3. Material: Plastic body with chrome-plated-brass cover.
4. Hose Connections: 16 mm ID inlet and 22 mm ID outlet.

2.15 SERVICE BASINS

A. Service Basins - MSGR, REP**,** SDA-Building-Janitor's-Closet: Floor-mounting, pre-cast terrazzo basin with rim guard.

1. Shape: Square.
2. Size: 610 by 610 mm.
3. Height: 255 mm.
4. Rim Guard: On front.
5. Faucet: Sink as specified for MSGR, REP, SDA.
6. Drain: DN 80 outlet, see faucet.

2.16 LAUNDRY TRAYS

A. Laundry Trays - MSGR, REP, SDA: Stand-mounting, enameled cast-iron laundry tray.

1. Size: 635 by 560 mm.
2. Color: White.
3. Faucet: As specified for MSGR, REP, SDA.
4. Supplies: DN 15 chrome-plated copper with stops.
5. Drain: DN 40 outlet, see faucet.
6. Drain Piping: DN 40 chrome-plated cast-brass trap, 1.1-mm- thick tubular brass waste to wall, and wall escutcheon.
7. Stand: Manufacturer's standard metal stand; provide finish if not pre-finished.

2.17 UTILITY SINK

A. Utility Sink - MSGR, REP, SDA: Stainless steel, free-standing on legs.

1. Size: 635 mm x 560 mm.
2. Faucet: As specified.
3. Supplies: DN 15 chrome-plated copper with stops.
4. Drain Piping: DN 40 chrome-plated cast-brass "p" trap, 1.1 mm thick tubular brass waste to wall, and wall escutcheon.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Provide adequate space around plumbing fixtures to allow for routine maintenance and repair.

C. For wall-hanging fixtures, install off-floor supports affixed to building substrate.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

D. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

E. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

F. Install wall-hanging fixtures with tubular waste piping attached to supports.

G. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

H. Install counter-mounting fixtures in and attached to casework.

I. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

J. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Refer to Division 22 Section on valves for general-duty valves.

K. Install "p" trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

L. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

S. Install traps on fixture outlets.

1. Exception: Omit trap on indirect wastes, unless otherwise indicated.

T. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

U. Install dishwasher air-gap fitting at each sink indicated to have fitting. Connect inlet hose to dishwasher and outlet hose to disposer.

V. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section for escutcheons.

W. Set bathtubs, shower receptors, and service basins in leveling bed of cement grout. Refer to Division 22 Section for grout.

X. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 07 Section on joint sealants for sealant and installation requirements.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

F. **[Test shower floors and receptors for water tightness according to the International Plumbing Code.]**

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Project Director/COR.

END OF SECTION 224105

SECTION 224215 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes plumbing fixtures and related components for office buildings (except private executive bathrooms), support buildings, recreational buildings, and public spaces in staff housing.

B. Related Sections include the following:

1. Section 114000 “Food Service Equipment” for kitchen fixtures not in this section.
2. Section 117000 “Medical Equipment” for equipment not in this section.
3. Division 22 Section on plumbing specialties for backflow preventers and specialty fixtures not in this section.
4. Section 224105 “Residential Plumbing Fixtures” for plumbing fixtures not in this section.
5. Section 224500 “Emergency Plumbing Fixtures.”
6. Division 10 Section on toilet compartments.
7. Division 22 Section on electric water coolers and drinking fountains.

1.2 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.3 SUBMITTALS

A. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1. Identify GreenSpec or WaterSense label where applicable (e.g., faucets, toilets, urinals, shower heads).

B. Wiring diagrams from manufacturer for electrically operated units, including for power, signal, and controls as applicable.

C. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals specified in Division 01.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components of a particular category are not available from a single manufacturer, prior to obtaining similar products from other manufacturers specified for that category, submit findings to Project Director/COR that a single manufacturer is not available for that category (identify specific fixtures exceptions) and secure concurrence from Project Director/COR for obtaining similar products from other manufacturers specified for that category.

B. If procured outside the U.S., fixtures must meet equivalent standard for performance and flow approved by Project Director/COR based on documentation provided to OBO/PDCS/DE mechanical engineer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to Project Director/COR and marked for intended use.

D. Regulatory Requirements: Comply with accessibility requirements of the Architectural Barriers Act (ABA) as identified in Chapter 11 of the OBO Building Code.

E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Finishes of fixtures within same rooms must match.

I. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Hand Sinks: NSF 2 construction.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
5. Vitreous-China Fixtures: ASME A112.19.2.
6. Water Closet, Flushometer Tank Trim: ASSE 1037.
7. Water Closet Personal Hygiene Devices: ASME A112.4.2

J. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3.

3. Faucet Hose: ASTM D 3901.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply and Drain Fittings: ASME A112.18.1.

K. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:

1. Automatic Compensating Valves for Individual Showers: ASSE 1016.
2. Faucets: ASME A112.18.1.
3. Backflow Prevention Devices for Hand-Held Showers: ASSE 1014.
4. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Pipe Threads: ASME B1.20.1.
7. Standard Consumer Safety Specification for Scald-Preventing Devices and Systems in Bathing Area: ASTM F444.
8. Combination Pressure Balanced and Thermostatic Valve: ASSE 1016.

L. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Manual-Operation Flushometers: ASSE 1037.
4. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
5. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1.

M. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.6.3.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Off-Floor Fixture Supports: ASME A112.6.1M.
6. Pipe Threads: ASME B1.20.1.
7. Plastic Toilet Seats: ANSI Z124.5.
8. Supply and Drain Protective Shielding Guards: Conforming to ABA.

1.5 EXTRA MATERIALS

A. Furnish the following to the Project Director/COR at project closeout.

1. Faucet Washers and O-Rings: 10 percent of each type.
2. Faucet Cartridge and O-Rings: 10 percent.
3. Flush Valves Repair Kits: 5 percent of fixtures.
4. Toilet Seat with Integral Bidet: 20 percent of units installed, but not less than one.
5. Toilet Seat with Integral Bidet Deodorizing Filters: Two filters per unit installed.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. General: All faucets, flushometers, water closets, and urinals must be water conserving, automatic devices, unless otherwise noted.

2.2 LAVATORY FAUCETS

A. Automatic Lavatory Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Maximum Flow Rate: 1.9 L/min., with automatic 10 second shutoff.
2. Body Material: Cast brass or copper or brass underbody with brass cover plate.
3. Finish: Polished chrome plate.
4. Centers: 102 mm.
5. Mounting: Deck, exposed.
6. Handle(s): Not applicable.
7. Inlet(s): DN 15 male shank.
8. Spout: Rigid.
9. Spout Outlet: Aerator.
10. Operation: Single battery powered, sensor operated, automatic.
11. Drain: Chrome plated grid.
12. Tempering Device: Adjustable hot limit safety stop.

B. Manual Lavatory Single-Control Faucet - Accessible: Single control mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

1. Maximum Flow Rate: 8.3 L/min.
2. Body Material: Cast brass or copper or brass underbody with brass cover plate.
3. Finish: **[Polished chrome plate][Brush chrome if approved by Project Director/COR]**.
4. Mounting: Deck, exposed.
5. Valve Handle(s): Comply with ABA.
6. Inlet(s): DN 15 male shank.
7. Spout: **[Rigid type][Rigid, gooseneck]**.

8. Spout Outlet: Aerator.
9. Operation: Compression, manual.
10. Drain: Grid type with DN32 offset tailpiece.
11. Tempering Device: Adjustable hot limit safety stop.
12. Labeling: WaterSense.

2.3 SHOWER FAUCETS

A. Shower Faucet: Include hot- and cold-water indicators. Coordinate faucet inlets with supplies and outlet with wall supply.

1. Maximum Flow Rate: 6.8 L/min.
2. Body Material: Cast brass.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Type: Single-handle thermostatic and pressure balance valve with provision to limit setting so that it does not exceed 49 deg C (120 deg F).
5. Mounting: Exposed.
6. Handles: Lever.
7. Operation: Compression, manual.
8. Antiscald Device: Integral with mixing valve.
9. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
10. Supply Connections: DN 15 female inlet, DN 15 male outlet.
11. Shower Head Material: Metallic with chrome-plated finish.
12. Head Type: Ball joint.
13. Spray Pattern: Adjustable.
14. Integral Volume Control: Required.
15. Shower-Arm, Flow-Control Fitting: Not required.
16. Labeling: WaterSense.

B. Shower Faucet - Accessible: Include hot- and cold-water indicators; soft handshower, hose, wall supply, and slide bar. Coordinate faucet inlets with supplies and outlet with wall supply.

1. Maximum Flow Rate: 6.8 L/min.
2. Body Material: Cast brass.
3. Finish: **[Polished chrome plate][Brushed chrome if approved by Project Director/COR]**.
4. Type: Single-handle thermostatic and pressure balance valve with provision to limit setting so that it does not exceed 49 deg C (120 deg F).
5. Mounting: Exposed.
6. Handles: Lever.
7. Backflow Protection Device for Handheld Shower: Required.
8. Operation: Compression, manual, conforming to ABA.
9. Antiscald Device: Integral with mixing valve.
10. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

11. Supply Connections: DN 15 female inlet, DN 15 male outlet.
12. Shower Head Material: Metallic with chrome-plated finish.
13. Head Type: Handheld, slide-bar mounted.
14. Spray Pattern: Adjustable.
15. Integral Volume Control: Required.
16. Hose: 1500 mm.
17. Labeling: WaterSense.

2.4 SINK FAUCETS

A. Kitchenette/Pantry/Lactation Room Sink Faucet: Kitchen faucet with**[out]** pull-down sprayer. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Maximum Flow Rate: 8.3 L/min., unless otherwise indicated.
2. Body Material: Cast brass.
3. Finish: Polished chrome plate.
4. Mixing Valve: Single lever-activated, washerless cartridge.
5. Centers: 203 mm.
6. Mounting: Deck, exposed.
7. Handle: Single, metal lever.
8. Inlets: DN 15 male shank.
9. Spout: 200-217 mm tubular swing.
10. Spout Outlet: Aerator.
11. Vacuum Breaker: Required.
12. Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.

B. Kitchenette/Pantry/Lactation Room Sink Faucet - Accessible: Kitchen faucet with**[out]** pull-down sprayer. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Maximum Flow Rate: 8.3 L/min unless otherwise indicated.
2. Body Material: Cast brass.
3. Finish: Polished chrome plate.
4. Mixing Valve: Single lever-activated, washerless cartridge.
5. Centers: 203 mm adjustable.
6. Mounting: Deck, exposed.
7. Handle: Single, metal lever, conforming to ABA.
8. Inlets: DN 15 male shank.
9. Spout: 200-217 mm tubular swing.
10. Spout Outlet: Aerator.
11. Vacuum Breaker: Required.
12. Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.

C. Laboratory Sink Faucet: Two handle mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Maximum Flow Rate: 8.3 L/min unless otherwise indicated.
2. Body Material: Cast brass.
3. Finish: Polished chrome plate.
4. Centers: 102 mm.
5. Mounting: Deck, exposed.
6. Handles: 100 mm forged Brass wrist blades.
7. Inlets: DN 15 male shank.
8. Spout: Brass gooseneck swing spout.
9. Spout Outlet: Aerator.
10. Vacuum Breaker: Required.
11. Operation: Compression, manual, by renewable unit with replaceable stainless steel seat.
12. Drain: Stainless steel crumb cup with removable stainless steel strainer basket with rubber stopper.
13. Tailpiece: DN 40 stainless steel, 102 mm long.
14. Eyewash: See faucet-mounted eyewash equipment in Section 224500 "Emergency Plumbing Fixtures."

D. Service Sink Faucet: Service sink faucet with stops in shanks, vacuum breaker, hose thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Body Material: Cast brass.
2. Finish: Polished chrome plate.
3. Mixing Valve: Two-lever handle.
4. Backflow Protection Device for Hose Outlet: Required.
5. Centers: Adjustable, 152 to 254 mm with offset shanks.
6. Mounting: **[Deck, exposed][Back, wall, exposed]**.
7. Handles: Knob.
8. Inlets: DN 15 male shank.
9. Spout: Rigid, solid brass with wall brace and bucket hook.
10. Spout Outlet: Hose thread
11. Vacuum Breaker: Required.
12. Operation: Compression, manual.
13. Drain: Grid.

E. Bar Sink Faucet: Centerset. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Body Material: Cast brass.
2. Maximum Flow Rate: 8.3 L/min.
3. Finish: **[Polished chrome plate][Brush chrome if approved by Project Director/COR]**.
4. Mixing Valve: Two-lever handle.
5. Backflow Protection Device for Hose Outlet: Required.
6. Centers: 102 mm.
7. Mounting: Deck, exposed.
8. Handles: Brass levers.
9. Inlets: DN 15 male shank.
10. Spout: Brass gooseneck swing spout.

11. Vacuum Breaker: Required.
12. Drain: Conical stainless steel strainer basket with flexible stem and rubber stopper.

F. Laundry and Utility Sink Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Body Material: Cast brass.
2. Maximum Flow Rate: 8.3 L/min., unless otherwise indicated.
3. Finish: Polished chrome plate.
4. Mixing Valve: Two-lever handle.
5. Backflow Protection Device for Hose Outlet: Required.
6. Centers: 102 mm.
7. Mounting: **[Deck, exposed][Back, wall, exposed]**.
8. Handles: Knob.
9. Inlets: DN 15 male threaded inlet shank.
10. Spout: Swing, solid brass.
11. Spout Outlet: Hose thread
12. Vacuum Breaker: Required.
13. Operation: Compression, manual.
14. Drain: Grid.

2.5 FLUSHOMETERS

A. Flushometer for water-closet type fixture. Cast-brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.

1. Internal Design: Diaphragm operation.
2. Style: Exposed.
3. Inlet Size: DN 25.
4. Trip Mechanism: Battery-operated sensor actuator.
5. Maximum Consumption: 4.8 L/flush
6. Tailpiece Size: DN 40 and length to top of bowl.

B. Flushometer for ultra-low flow urinal-type fixture. Cast-brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.

1. Internal Design: Diaphragm operation.
2. Style: Exposed.
3. Inlet Size: DN 20.
4. Trip Mechanism: Battery-operated sensor actuator.
5. Maximum Consumption: 0.473 L/flush.
6. Tailpiece Size: DN 40 and length to top of bowl.
7. Labeling: GreenSpec Listed or WaterSense.

C. [Flushometer for dual-flush water-closet-type fixture. Cast-brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts. Include metal wall plates etched with instructions.

1. Internal Design: Diaphragm operation.
2. Style: Exposed.
3. Inlet Size: DN 25.
4. Trip Mechanism: Lever-handle actuator.
5. Maximum Consumption: Dual flush, 4.8 L/flush and 4.2 L/flush.
6. Tailpiece Size: DN 40 and length to top of bowl.]

2.6 TOILET SEATS

A. Toilet Seat: Solid plastic.

1. Configuration: Open front without cover.
2. Size: Elongated.
3. Class: Heavy-duty commercial.
4. Hinge Type: SS, self-sustaining.
5. Color: White.

B. Toilet seat with integral bidet. Integral spray SS nozzle and retractable sprayer with self-cleaning feature.

1. Configuration: Open front without cover and side-arm control panel.
2. Size: Elongated.
3. Class: Heavy-duty commercial.
4. Hinge Type: SS, self-sustaining.
5. Color: White

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Enclosures: High-impact, stain resistant vinyl enclosure, specifically manufactured for enclosing hot- and cold-water supplies, trap and drain piping, electronic faucet connections, and mixing valves under wall hung lavatories complying with accessibility requirements of the ABA.

B. Protective Shielding Pipe Covers: Molded, closed-cell anti-microbial vinyl seamless P-trap insulation kit furnished with seamless riser tubes, supply angle stop covers, seamless drain tailpiece cover, and angle stop wheel handle covers. Comply with accessibility requirements of the ABA.

2.8 FIXTURE SUPPORTS

A. Water-Closet Support: Water-closet combination carrier designed for accessible and standard mounting height. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

B. Urinal Support: Urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include steel uprights with feet.

1. Accessible Fixture Support: Include rectangular steel uprights, conforming to ABA.

C. Lavatory Support: Lavatory carrier with concealed arms and tie rod. Include steel uprights with feet.

1. Accessible Fixture Support: Include rectangular steel uprights, conforming to ABA.

2.9 DISPOSERS

A. Batch-feed, household, food-waste disposer. Include 220 VAC, 559 W (0.75 HP) motor, local frequency (50 Hz or 60 Hz), with overload protection and reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; DN 40 outlet; quick-mounting, stainless-steel sink flange; anti-splash guard; and combination cover/stopper.

2.10 [HOT-WATER DISPENSERS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components – Health Effects," for faucet materials that will be in contact with potable water.

B. Hot-Water Dispensers:

1. Standard: ASSE 1023.
2. General: Household-type dispenser with instant on-off control; insulated, corrosion-resistant-metal storage tank that is open to atmosphere; electric heating element; chrome-plated faucet or spout; removable strainer; thermostat control for water temperature up to 88 deg C (190 deg F); and thermal-overload protection.
3. Storage Tank Capacity: 1.5 L (0.5 gal.).
4. Heating Element: 750 W minimum, 115-V ac.]

2.11 WATER CLOSETS

A. Water Closets: Wall-mounting, back-outlet, and vitreous-china fixture designed for flushometer valve operation.

1. Style: Flushometer valve.

a. Bowl Type: Elongated with siphon-jet design.
b. Maximum Consumption: 4.8 L/flush.
c. Color: White.

2. Flushometer: As specified for water closet without dual flush.
3. Toilet Seat: As specified.
4. Fixture Support: Water-closet support combination carrier.

B. Water Closets - Accessible: Accessible, wall-mounting, back-outlet, and vitreous-china fixture designed for flushometer valve operation.

1. Style: Flushometer valve.

a. Bowl Type: Elongated with siphon-jet design.
b. Maximum Consumption: 4.8 L/flush.
c. Color: White.

2. Flushometer: As specified for water closet without dual flush.
3. Toilet Seat: As specified.
4. Fixture Support: Water-closet support combination carrier, conforming to ABA.

C. [Water Closets – Dual Flush: Dual-flush, wall-mounting, back-outlet, and vitreous-china fixture designed for flushometer valve operation.

1. Style: Flushometer valve.

a. Bowl Type: Elongated with siphon-jet design.
b. Maximum Consumption: Dual flush, 4.8 L/flush and 4.2 L/flush.
c. Color: White.

2. Flushometer: As specified for water closet with dual flush.
3. Toilet Seat: As specified.
4. Fixture Support: Water-closet support combination carrier as specified.]

2.12 URINALS

A. Urinals: Ultra-low flow urinal, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

1. Type: Siphon Jet.
2. Strainer or Trapway: Integral cast strainer.
3. Design Consumption: 0.473 L/flush.
4. Color: White.
5. Supply Spud Size: DN 20.
6. Outlet Size: DN 50.
7. Flushometer: As specified.
8. Fixture Support: As specified.
9. Labeling: GreenSpec or WaterSense.

B. Urinals - Accessible: Ultra-low flow urinal, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

1. Type: Siphon Jet
2. Strainer or Trapway: Integral cast strainer.
3. Design Consumption: 0.473 L/flush.
4. Color: White.
5. Supply Spud Size: DN 20.
6. Outlet Size: DN 50.
7. Flushometer: As specified.
8. Fixture Support: As specified.
9. Labeling: GreenSpec or WaterSense.

2.13 LAVATORIES

A. Wall-Hanging Lavatories: Standard and accessible (conforming to ABA), vitreous-china fixture.

1. Type: With contoured back.
2. Size: 508 by 457 mm rectangular.
3. Faucet Hole Punching: Three, 102-mm centers holes.
4. Faucet Hole Location: Top.
5. Color: White.
6. Faucet: As specified.
7. Supplies: DN 10 chrome-plated copper with stops.
8. Drain: See faucet.
9. Drain Piping: DN 32 by DN 40 chrome-plated cast-brass “p” trap; DN 40 thick tubular brass waste to wall; and wall escutcheon.
10. Protective Shielding Guard: As specified.
11. Fixture Support: Lavatory, as specified.

B. Counter-Mounted Lavatories: Standard and accessible (conforming to ABA), vitreous-china fixture.

1. Type: Self-rimming.
2. Oval Lavatory Size: 508 by 432 mm.
3. Faucet Hole Punching: Three, 102-mm centers, holes.
4. Faucet Hole Location: Top.
5. Color: White.
6. Faucet: Lavatory. As specified.
7. Supplies: DN 10 chrome-plated copper with stops.
8. Drain: See faucet.
9. Drain Piping: DN 32 chrome-plated cast-brass “p” trap; DN 40 thick tubular brass waste to wall; and wall escutcheon.
10. Protective Shielding Guard: As specified.

2.14 SINKS

A. Kitchenette/Pantry/Lactation Sink: Counter-mounting, self-rimming, Type 304, 18-8 stainless steel sink.

1. Overall Size: 559 by 432 mm.
2. Number of Compartments: One.
3. Bowl Depth: 165 mm.
4. Sink Faucet: As specified.
5. Supplies: DN 15 chrome-plated copper with stops.
6. Mounting Holes: Three.
7. Drain Opening: 89 mm, off-center - 114mm from back. Position electrical outlet for disposer.
8. Drain: See faucet.
9. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1-mm- thick tubular brass waste to wall, continuous waste, and wall escutcheon(s).
10. Underside: Fully coated to dampen sound and prevent condensation.
11. Disposer: As specified.

B. Laboratory Sink: Single-compartment, counter-mounting, Type 304 18-8 stainless-steel fixture. Fixture must conform to ASME/ANSI A112.19.3M.

1. Overall Size: 483 by 534 mm.
2. Compartment: 356 by 457 mm, with straight sides and 45 mm radius corners
3. Finish: Hand-blended, with highlighted rim.
4. Rim: Self-rimming fixture with 300 series stainless steel mounting channels.
5. Sink Faucet: As specified.
6. Supplies: DN 15 chrome-plated copper with stops.
7. Drain: see faucet.
8. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1-mm- thick tubular brass waste to wall, and wall escutcheon.
9. Underside: Fully coated to dampen sound and prevent condensation.
10. Mounting Holes: Three, on 102 mm centers.

C. Bar Sink: Single-compartment, counter-mounting, stainless-steel fixture.

1. Size: 432 by 508 mm.
2. Sink Faucet: As specified.
3. Supplies: DN 15 chrome-plated copper with stops.
4. Drain: see faucet.
5. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1-mm- thick tubular brass waste to wall, and wall escutcheon.
6. Underside: Fully coated to dampen sound and prevent condensation.

2.15 SERVICE BASINS

A. Service Basins: Floor-mounting, pre-cast terrazzo basin with rim guard.

1. Shape: Square.
2. Size: 610 by 610 mm.
3. Height: 255 mm.
4. Rim Guard: On front.
5. Faucet: Sink as specified.
6. Drain: DN 80 outlet, see faucet.

2.16 INDIVIDUAL SHOWERS

A. Shower Fixtures: Refer to Division 10 for shower receptor and shower accessories.

1. Faucet/shower: As specified.
2. Drain: DN 50 outlet with chrome plated brass grate.

2.17 LAUNDRY TRAYS

A. Stand-mounting, enameled cast-iron laundry tray.

1. Size: 635 mm x 560 mm.
2. Color: White.
3. Faucet: As specified.
4. Supplies: DN 15 chrome-plated copper with stops.
5. Drain: DN 40 outlet; see faucet.
6. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1 mm thick tubular brass waste to wall, and wall escutcheon.
7. Stand: Manufacturer’s standard metal stand; provide finish if not pre-finished.

2.18 UTILITY SINK

A. Stainless steel, free-standing on legs.

1. Size: 635 mm x 560 mm.
2. Faucet: As specified.
3. Supplies: DN 15 chrome-plated copper with stops.
4. Drain Piping: DN 40 chrome-plated cast-brass “p” trap, 1.1 mm thick tubular brass waste to wall, and wall escutcheon.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Accessible Fixtures:

1. Install accessible fixtures at mounting height required by the ABA.
2. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping for accessible lavatories in accordance with the ABA.

C. Provide adequate space around plumbing fixtures to allow for routine maintenance and repair.

D. For wall-hanging fixtures, install off-floor supports affixed to building substrate.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

E. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

F. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

G. Install wall-hanging fixtures with tubular waste piping attached to supports.

H. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

I. Install counter-mounting fixtures in and attached to casework.

J. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

K. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball valve if stops are not specified with fixture. Refer to Division 22 Section on general-duty valves for plumbing piping.

L. Install "p" trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

M. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

N. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

O. Install toilet seats on water closets.

P. **[For dual flush water closet, install instructional metal wall plate above fixture.]**

Q. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

S. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

T. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

U. Install traps on fixture outlets.

1. Exception: Omit trap on indirect wastes, unless otherwise indicated.

V. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

W. **[Install hot-water dispensers in back top surface of sink or in counter with spout over sink.]**

X. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section for escutcheons.

Y. Set bathtubs, shower receptors, and service basins in leveling bed of cement grout. Refer to Division 22 Section for grout.

Z. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 07 Section on joint sealants for product and installation requirements.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect cold water supply from water distribution to toilet seat with integrated bidet.

D. Connect drain piping from fixtures to drainage piping.

E. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

F. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

G. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

F. Test shower floors and receptors for water tightness according to provisions in Chapter 3 of the model International Plumbing Code.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers**[, hot-water dispensers,]** and associated controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Project Director/COR.

END OF SECTION 224215

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following emergency plumbing fixtures:

1. Plumbed eyewash equipment.
2. Self-contained eyewash equipment.
3. Combination eyewash and emergency shower or safety station.
4. Deck-mounted equipment.

B. Related Sections include the following:

1. Division 22 Section "Plumbing Specialties" for backflow preventers and floor drains.

1.2 PERFORMANCE REQUIREMENTS

A. Provide emergency plumbing fixtures in accordance with requirements in Chapter 4 of the OBO Plumbing Code for location and travel distance.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: Submit certificates of performance testing specified in the Part 2 Article on SOURCE QUALITY CONTROL.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

B. Regulatory Requirements: Comply with accessibility provisions in Chapter 11 of the Building Code of Overseas Buildings Operations.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing-Fluid Solution for Self-Contained Eyewash Equipment: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.1 PLUMBED EYEWASH AND EMERGENCY SHOWER EQUIPMENT

A. Basis of Design: The following products represent models conforming to requirements. The list is not intended to indicate a requirement for sole-source acquisition.

1. Plumbed eyewash equipment

a. Guardian G1891
b. Guardian G1892
c. Guardian G1825
d. Guardian G1825P
e. Guardian G1894
f. Guardian G1896

2. Combination eyewash and emergency shower or safety station

a. Haws 8200
b. Haws 8300.158

3. Deck-mounted eyewash equipment

a. Bradley - S19-270HDSpeakman - SE-573
b. Guardian G1849

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bradley Corporation.
2. Chicago Faucets.
3. Encon Safety Products.
4. Guardian Equipment Co.
5. Haws Corporation.
6. Lab Safety Supply Inc.
7. Sellstrom Manufacturing Co.
8. Speakman Company.
9. WaterSaver Faucet Co.
10. Western Emergency Equipment.

C. Description: Plumbed, accessible equipment.

1. General:

a. Supply Piping: DN 15 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
b. Control-Valve Actuator: Paddle.
c. Receptor: Chrome-plated brass, stainless-steel bowl, or ABS plastic.
d. Drain Piping: DN 32 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.
e. Mixing Valve: Thermostatic mixing valve (TMV) complying with ASSE 1071, leaving water temperature setpoint adjustable throughout the range of 16 to 35 degrees C (60 to 95 degrees F).

2. Plumbed eyewash equipment: Wall-mounted, pedestal, or deck-mounted equipment.

2.2 SELF-CONTAINED EYEWASH EQUIPMENT

A. Basis of Design: The following products represent models conforming to requirements. The list is not intended to indicate a requirement for sole-source acquisition.

1. Self-contained eyewash equipment

a. Bradley S19-921
b. Bradley S19-921H (heated model)

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bradley Corporation.
2. Encon Safety Products.

3. Guardian Equipment Co.
4. Haws Corporation.
5. Lab Safety Supply Inc.
6. Sellstrom Manufacturing Co.
7. Speakman Company.
8. WaterSaver Faucet Co.
9. Western Emergency Equipment.

C. Description: Portable, pressurized, self-contained eyewash equipment.

1. Capacity: Deliver flushing fluid at rate not less than 1.5 L/min. (for at least 15 minutes.
2. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
3. Provide heated unit where required to prevent freezing.

2.3 SOURCE QUALITY CONTROL

A. Certify performance of plumbed and self-contained emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section on general-duty valves for plumbing piping.

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency plumbing fixture.

E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping.

F. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Section on common work results for plumbing.

G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.

H. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section on sanitary waste and vent piping.

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Section on common work results for plumbing.

J. Fill self-contained fixtures with flushing fluid.

K. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 22 Section on identification for plumbing piping and equipment.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot- and cold-water supplies to emergency showers and plumbed emergency eyewash stations. Comply with manufacturer's installation instructions. The temperature of the water supply must be controlled by a thermostatic mixing valve (TMV) complying with ASSE 1071.

C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.

D. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

1. P-trapped drain is required when receptors drain outlet connected to sanitary drainage and vent piping.

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

C. Report test results in writing.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

END OF SECTION 224500

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Measuring sound and vibration.
7. Reporting results of the activities and procedures specified in this Section.
8. Measuring and making adjustments necessary to maintain building pressurization levels in buildings in accordance with system design.

B. Related Sections include the following:

1. Those testing and adjusting requirements which are unique to particular systems and equipment are included in the associated Sections that specify those systems and equipment.
2. Field quality-control testing to verify that workmanship quality for systems and equipment installation are specified in the associated Sections for those systems and equipment.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

D. CxA: Commissioning Agent. Refer to Division 01 Section “Commissioning.”

E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

F. Functional Performance Testing (FPT): Refer to Division 01 Section “Commissioning.”

G. NEBB: National Environmental Balancing Bureau.

H. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

I. Report Forms: Test data sheets for recording test data in logical order.

J. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

K. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

N. TAB: Testing, adjusting, and balancing.

O. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

P. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

Q. Test: A procedure to determine quantitative performance of a system or equipment.

1.3 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed with construction, submit four copies of evidence that testing, adjusting, and balancing agent meets the qualifications specified in the Part 1 Article on QUALITY ASSURANCE.

B. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed with construction, submit four copies of Contract Documents review report as specific in Part 3.

C. Strategies and Procedures Plan: Within 90 days from Contractor's Notice to Proceed, submit four copies of testing, adjusting, and balancing strategies and step-by-step procedures as specified in the Part 3 Article on PREPARATION. Include a complete set of report forms intended for use on this Project.

D. Certified Testing, Adjusting, and Balancing Reports: Submit two copies of reports prepared, as specified in this Section, on forms conforming to requirements of the Part 1 Article on QUALITY ASSURANCE.

E. Instrument calibration reports, including the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Specialist Qualifications: Engage a testing, adjusting, and balancing specialist certified by either Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB).

1. TAB Field Supervisor: Employee of TAB Specialist and certified by AABC or NEBB.
2. TAB Technician: Employee of TAB Specialist and certified by AABC or NEBB as TAB technician.

B. Perform testing, adjusting and balancing in accordance with ANSI/ASHRAE Standard 111-2008 (RA 2017) “Testing, Adjusting, and Balancing of Building HVAC Systems.”

C. Testing, Adjusting, and Balancing Conference: TAB Specialist shall meet with the Project Director/COR and the project Commissioning Agent upon approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
b. Contract Documents examination report.
c. Testing, adjusting, and balancing plan.
d. Work schedule and Project site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

D. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
3. TAB Specialist shall review, backcheck, verify, and demonstrate all tests results after the Functional Performance Testing (FPT) is complete and prior to CxA Warranty Review.
4. Operate, demonstrate, and verify all the air systems to 100 percent design rated duty for air flows, with all systems in operation (not just individual systems) as designed for full

occupation of each building and as necessary to maintain the applicable pressurization requirements.

E. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" each time a testing, adjusting, and balancing report is created.

F. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards if AABC report form is used or as described in NEBB's "Procedural Standard for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification" if NEBB report form is used.

G. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.5 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Obtain all Division 23 shop drawings of systems to be tested, adjusted, and balanced to become familiar with installation prior to the day when testing, adjusting, and balancing is performed.

C. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

D. Perform testing, adjusting, and balancing after leakage, pressure tests, and specified flushing, and cleaning and chemical treatment on air and water distribution systems have been satisfactorily completed.

E. Initial TAB verification activity shall be performed prior to Functional Performance Testing (FPT).

F. TAB Specialist shall revalidate all TAB results after FPTs are complete since conditions may have been affected by adjustments to issues found and corrected in the FPT process. In addition, revalidation is necessary at two peak seasons. Refer to the Part 3 Article on ADDITIONAL TESTS.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are provided as required by the design in the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine project record documents described in Division 01 Section "Closeout Procedures."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10 from Air Movement and Control Association International, Inc. (AMCA); or in SMACNA's "HVAC Systems Duct Design," Sections 5 and 6 by Sheet Metal and Air Conditioning Contractors' National Association (SMACNA). Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and prefunctional checklist specified in individual Specification Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that these items are accessible and associated controls are connected and functioning.

L. Examine plenum ceilings utilized for supply air to verify air tightness. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows and design fail-safe positions.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

S. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

T. Examine signed pre-functional and start-up checklists pertaining to applicable system/equipment. Ensure these documents have been submitted by installing contractor and verify that system/equipment is functioning in accordance with design intent prior to beginning any TAB fieldwork.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, chemically treated as specified, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balancing, smoke, and fire dampers are fully open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in Associated Air Balance Council (AABC) national standards or National Environmental Balancing Bureau (NEBB) "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," and the requirements of this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the Division 23 insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Demonstrate operation of each pressure zone to Project Director/COR during installation and at commissioning for compliance with requirements and conformance to system design in Construction Documents.

M. Demonstrate that pressure settings do not affect opening and closing of FE/BR doors.

N. Consular Teller Window Air Flow: Demonstrate that system design provides required airflow from Consular Affairs suite to Consular Waiting Area through consular window deal trays when one or more deal trays are opened.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume supply-air systems. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.

   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Adjust fan speed higher or lower than design with the approval of the Project Director/COR with input from OBO/PDCS/DE/ME and project designer. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 ADDITIONAL PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
3. Measure total design system airflow.

    a. Adjust total design supply air from 100 percent to +/-5 percent (i.e., range from 95 percent to 105 percent).
    b. Adjust total design return air from 100 percent to -5 percent (i.e., range 95 percent to 100 percent).
    c. Exhaust air to be balanced to achieve the designed pressure differential for the associated areas.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

3.7 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus-or-minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at design flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
9. TAB Specialist must provide assistance to the Cx team to measure and document water flow using portable ultrasonic liquid flow meter capable of measuring liquid flow in various size and compositions of materials (e.g., copper, PVC, carbon steel). Examples of typical measurements include flows for chilled water bypass lines, chiller evaporator flow rates, coil flows, totals system flows for chilled water, and heat exchanger flow rates.
10. TAB Specialist shall verify accuracy of readings from hydronic system flow meters used by BAS Systems.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.

    a. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.
    b. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
    c. Report flow rates that are not within plus-or-minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.

E. Adjust balancing stations to within specified tolerances of design flow rate as follows:

1. Determine the balancing station with the highest percentage over design flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 ADDITIONAL PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 ADDITIONAL PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Record safety valve settings.

E. Verify operation of steam traps.

3.12 PROCEDURES FOR MOTORS

A. Motors, 373 W (0.5 HP) and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data. Verify that minimum frequency (Hz) set points do not allow fans or pumps to operate within "surge portion" of their respective submitted curves.

C. Vibration Testing:

1. TAB Specialist shall perform vibration measurements on all motors 5 HP and greater in size. Typically, for HVAC these motors are associated with pumps and fan systems.
2. Perform measurements at a fixed repeatable speed.
3. Perform measurements at each end of motor and bearing point.
4. Perform measurement on clean dry flat surfaces; if flat surfaces are not available, use curved surface sensor.
5. Measurement shall include both accelerations measured in 10 to 1000 Hz range, and velocity measured in 200 to 16k Hz range. Velocity measurement is used to gauge general motor condition, and velocity is used to gauge bearing condition.
6. Measurements will form a baseline for future condition monitoring.
7. TAB Specialist shall document each individual motor being tested (make, model, name), accelerometer/sensor location on motor, and maximum vibration measurements observed, along with corresponding RPM or motor load. Measurements from all vibration tests shall be incorporated in a consolidated report. This report will serve as the baseline for future comparison and troubleshooting by Facilities staff.

3.13 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of design flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator water entering and leaving temperatures, pressure drop, and water flow.
2. Condenser water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by the chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kW.
5. The kW input if factory-installed instrumentation is furnished for measuring kW.
6. Capacity: Calculate in tons of cooling.

7. Air-Cooled Chillers: Verify condenser-fan rotation and record fan data, including number of fans and entering- and leaving-air temperatures.

8. Chillers shall be commissioned on-site by the manufacturer and accepted by Project Director/COR based on input from OBO/PDCS/DE mechanical engineer.

3.14 [PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and then ensure the makeup and blow-down systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser water flow rate recirculating through the cooling tower.
6. Measure cooling tower pump discharge pressure.
7. Adjust water level and feed rate of makeup-water system.]

3.15 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

3.16 PROCEDURES FOR BOILERS

A. Measure entering- and leaving-water temperatures and water flow.

3.17 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperatures.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperatures of entering and leaving air.
5. Wet-bulb temperatures of entering and leaving air for cooling coils designed for less than 3540 L/s.
6. Airflow.
7. Air pressure drop.

3.18 PROCEDURES FOR TEMPERATURE TESTING

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.19 PROCEDURES FOR TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Verify main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or ungrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.20 PROCEDURES FOR HVAC SOUND LEVEL TESTING

A. TAB Specialist shall measure, verify compliance, and demonstrate to the Project Director/COR and Cx Agent that internal noise levels for HVAC systems in associated spaces conform to OBO-ICS IBC 1206.4 Noise restrictions for equipment.

3.21 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, Exhaust Fans, and Equipment with Fans: 0 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Chilled-Water Flow Rate: 0 to minus 5 percent.
5. Condenser-Water Flow Rate: 0 to minus 10 percent.

3.22 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in the Part 3 Article on EXAMINATION, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

C. Deliver to Project Director/COR a field copy of TAB results for equipment/systems, for Government review, one week prior to functional performance testing.

3.23 FINAL REPORT

A. Submit final test reports to Project Director/COR for forwarding to the OBO/OPS/FAC for inclusion in the Maintenance Database.

B. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

C. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

D. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.

5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

E. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of testing, adjusting, and balancing Agent.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing, adjusting, and balancing Agent who certifies the report.
10. Summary of contents, including the following:

    a. Design versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.
12. Data for terminal units, including manufacturer, type size, and fittings.
13. Notes to explain why certain final data in the body of reports vary from design values.
14. Test conditions for fans and pump performance forms, including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings, including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

F. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Tag identification numbers for major equipment, valve and damper components,

G. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in mm, and bore.
   i. Sheave dimensions, center-to-center and amount of adjustments in mm.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data: Include the following:

   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in mm, and bore.
   f. Sheave dimensions, center-to-center and amount of adjustments in mm.

3. Test Data: Include design and actual values for the following:

   a. Total airflow rate in L/s.
   b. Total system static pressure in Pa.
   c. Fan rpm.
   d. Discharge static pressure in Pa.
   e. Filter static-pressure differential in Pa.
   f. Preheat coil static-pressure differential in Pa.
   g. Cooling coil static-pressure differential in Pa.
   h. Heating coil static-pressure differential in Pa.
   i. Outside airflow in L/s.
   j. Return airflow in L/s.
   k. Outside-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

H. Apparatus-Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:

   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in mm o.c.

f. Make and model number.
g. Face area in sq. m.
h. Tube size in DN.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in L/s.
b. Average face velocity in m/s.
c. Air pressure drop in Pa.
d. Outside-air, wet- and dry-bulb temperatures in deg C.
e. Return-air, wet- and dry-bulb temperatures in deg C.
f. Entering-air, wet- and dry-bulb temperatures in deg C.
g. Leaving-air, wet- and dry-bulb temperatures in deg C.
h. Water flow rate in L/s.
i. Water pressure differential in kPa.
j. Entering-water temperature in deg C.
k. Leaving-water temperature in deg C.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in kPa.
n. Refrigerant suction temperature in deg C.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in mm, and bore.
h. Sheave dimensions, center-to-center and amount of adjustments in mm.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in mm, and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in mm.
g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in L/s.
b. Total system static pressure in Pa.
c. Fan rpm.
d. Discharge static pressure in Pa.
e. Suction static pressure in Pa.

J. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg C.
d. Duct static pressure in Pa.
e. Duct size in mm.
f. Duct area in sq. m.
g. Design airflow rate in L/s.
h. Design velocity in m/s.
i. Actual airflow rate in L/s.
j. Actual average velocity in m/s.
k. Barometric pressure in Pa.

K. Air-Terminal-Device Reports: For terminal units, include the following:

1. Unit Data: Include the following:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. m.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in L/s.
b. Air velocity in m/s.
c. Preliminary airflow rate as needed in L/s.
d. Preliminary velocity as needed in m/s.
e. Final airflow rate in L/s.
f. Final velocity in m/s.
g. Space temperature in deg C.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data: Include the following:

   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data: Include design and actual values for the following:

   a. Airflow rate in L/s.
   b. Entering-water temperature in deg C.
   c. Leaving-water temperature in deg C.
   d. Water pressure drop in kPa.
   e. Entering-air temperature in deg C.
   f. Leaving-air temperature in deg C.

M. Packaged Chiller Reports: For each chiller, include the following:

1. Unit Data: Include the following:

   a. Unit identification.
   b. Make and model number.
   c. Manufacturer's serial number.
   d. Refrigerant type and capacity in L.
   e. Starter type and size.
   f. Starter thermal protection size.

2. Condenser Test Data: Include design and actual values for the following:

   a. Refrigerant pressure in kPa.
   b. Refrigerant temperature in deg C.
   c. Entering-water temperature in deg C.
   d. Leaving-water temperature in deg C.
   e. Entering-water pressure in kPa.
   f. Water pressure differential in kPa.

3. Evaporator Test Reports: Include design and actual values for the following:

   a. Refrigerant pressure in kPa.
   b. Refrigerant temperature in deg C.
   c. Entering-water temperature in deg C.
   d. Leaving-water temperature in deg C.
   e. Entering-water pressure in kPa.
   f. Water pressure differential in kPa.

4. Compressor Test Data: Include design and actual values for the following:

   a. Make and model number.

b. Manufacturer's serial number.
c. Suction pressure in kPa.
d. Suction temperature in deg C.
e. Discharge pressure in kPa.
f. Discharge temperature in deg C.
g. Oil pressure in kPa.
h. Oil temperature in deg C.
i. Voltage at each connection.
j. Amperage for each phase.
k. The kW input.
l. Crankcase heater kW.
m. Chilled water control set point in deg C.
n. Condenser water control set point in deg C.
o. Refrigerant low-pressure-cutoff set point in kPa.
p. Refrigerant high-pressure-cutoff set point in kPa.

5. Refrigerant Test Data: Include design and actual values for the following:

a. Oil level.
b. Refrigerant level.
c. Relief valve setting in kPa.
d. Unloader set points in kPa.
e. Percentage of cylinders unloaded.
f. Bearing temperatures in deg C.
g. Vane position.
h. Low-temperature-cutoff set point in deg C.

N. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Unit make and model number.
d. Manufacturer's compressor serial numbers.
e. Compressor make.
f. Compressor model and serial numbers.
g. Refrigerant weight in kg.
h. Low ambient temperature cutoff in deg C.

2. Test Data: Include design and actual values for the following:

a. Inlet-duct static pressure in Pa.
b. Outlet-duct static pressure in Pa.
c. Entering-air, dry-bulb temperature in deg C.
d. Leaving-air, dry-bulb temperature in deg C.

e. Condenser entering-water temperature in deg C.
f. Condenser leaving-water temperature in deg C.
g. Condenser water temperature differential in deg C.
h. Condenser entering-water pressure in kPa.
i. Condenser leaving-water pressure in kPa.
j. Condenser water pressure differential in kPa.
k. Control settings.
l. Unloader set points.
m. Low-pressure-cutout set point in kPa.
n. High-pressure-cutout set point in kPa.
o. Suction pressure in kPa.
p. Suction temperature in deg C.
q. Condenser refrigerant pressure in kPa.
r. Condenser refrigerant temperature in deg C.
s. Oil pressure in kPa.
t. Oil temperature in deg C.
u. Voltage at each connection.
v. Amperage for each phase.
w. The kW input.
x. Crankcase heater kW.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in L/s.
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

O. Cooling Tower or Condenser Test Reports: For cooling towers or condensers, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Make and type.
c. Model and serial numbers.
d. Nominal cooling capacity in kW.
e. Refrigerant type and weight in kg.
f. Water-treatment chemical feeder and chemical.
g. Number and type of fans.
h. Fan motor make, frame size, rpm, and horsepower.
i. Fan motor voltage at each connection.
j. Sheave make, size in mm, and bore.
k. Sheave dimensions, center-to-center and amount of adjustments in mm.
l. Number of belts, make, and size.

2. Pump Test Data: Include design and actual values for the following:

a. Make and model number.

b. Manufacturer's serial number.
c. Motor make and frame size.
d. Motor horsepower and rpm.
e. Voltage at each connection.
f. Amperage for each phase.
g. Water flow rate in L/s.

3. Water Test Data: Include design and actual values for the following:

a. Entering-water temperature in deg C.
b. Leaving-water temperature in deg C.
c. Water temperature differential in deg C.
d. Entering-water pressure in kPa.
e. Leaving-water pressure in kPa.
f. Water pressure differential in kPa.
g. Water flow rate in L/s.
h. Bleed water flow rate in L/s.

4. Air Data: Include design and actual values for the following:

a. Duct airflow rate in L/s.
b. Inlet-duct static pressure in Pa.
c. Outlet-duct static pressure in Pa.
d. Average entering-air, wet-bulb temperature in deg C.
e. Average leaving-air, wet-bulb temperature in deg C.
f. Ambient wet-bulb temperature in deg C.

P. Heat-Exchanger Test Reports: For hot-water heat exchangers, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
f. Ratings.

2. Primary Water Test Data: Include design and actual values for the following:

a. Entering-water temperature in deg C.
b. Leaving-water temperature in deg C.
c. Entering-water pressure in kPa.
d. Water pressure differential in kPa.
e. Water flow rate in L/s.

3. Secondary Water Test Data: Include design and actual values for the following:

a. Entering-water temperature in deg C.

b. Leaving-water temperature in deg C.
c. Entering-water pressure in kPa.
d. Water pressure differential in kPa.
e. Water flow rate in L/s.

4. Pump Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in L/s.
g. Water pressure differential in kPa.
h. Required net positive suction head (NPSHR) in kPa.
i. Pump rpm.
j. Impeller diameter in mm.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

5. Pump Test Data: Include design and actual values for the following:

a. Static head in kPa.
b. Pump shutoff pressure in kPa.
c. Actual impeller size in mm.
d. Full-open flow rate in L/s.
e. Full-open pressure in kPa.
f. Final discharge pressure in kPa.
g. Final suction pressure in kPa.
h. Final total pressure in kPa.
i. Final water flow rate in L/s.
j. Voltage at each connection.
k. Amperage for each phase.
l. Net Positive Suction Head.

Q. Boiler Test Reports: For boilers, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.

f. Fuel type and input in kW.
g. Number of passes.
h. Ignition type.
i. Burner-control types.
j. Voltage at each connection.
k. Amperage for each phase.

2. Test Data: Include design and actual values for the following:

a. Operating pressure in kPa.
b. Operating temperature in deg C.
c. Entering-water temperature in deg C.
d. Leaving-water temperature in deg C.
e. Number of safety valves and sizes in DN.
f. Safety valve settings in kPa.
g. High-limit setting in kPa.
h. Operating-control setting.
i. High-fire set point.
j. Low-fire set point.
k. Voltage at each connection.
l. Amperage for each phase.
m. Draft fan voltage at each connection.
n. Draft fan amperage for each phase.
o. Manifold pressure in kPa.

R. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.24 ADDITIONAL TESTS

A. Perform within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing as an initial verification that balanced conditions are being maintained throughout and to correct unusual conditions. If this testing and balancing occurs at near-peak summer conditions or near-peak winter conditions, then the associated additional seasonal inspections, testing, and adjusting for that season may be performed at the same time.

B. Additional Seasonal Visits:

1. TAB Specialist shall visit site and perform seasonal inspections, testing, and adjusting for HVAC equipment for the following conditions which were not included in the initial verification testing:

a. Near-Peak Summer Conditions: If initial testing, adjusting, and balancing procedures for cooling systems were not performed during near-peak summer conditions, perform additional inspections, testing, and adjusting during near-peak summer conditions.
b. Near-Peak Winter Conditions: If initial testing, adjusting, and balancing procedures for heating systems were not performed during near-peak winter conditions, perform additional inspections, testing, and adjusting during near-peak winter conditions.

C. Notice: Provide notice to Project Director/COR 14 days in advance of each test. Include scheduled test dates and time in notice.

END OF SECTION 230593

SECTION 230719 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes insulation for the following HVAC piping systems:

1. Condensate drain piping, indoors and outdoors.
2. Chilled-water and brine piping, indoors and outdoors.
3. Condenser-water piping, indoors when used for water-side economizer or for condensate control and outdoors.
4. Heating hot-water piping, indoors and outdoors.
5. Steam and steam condensate piping, indoors and outdoors.
6. Refrigerant suction and hot-gas piping, indoors and outdoors.
7. Dual-service heating and cooling piping, indoors and outdoors.
8. Heat-recovery piping, indoors and outdoors.
9. Heated fuel-oil piping, indoors and outdoors.
10. Boiler feedwater piping, indoors and outdoors.
11. Flash steam piping, indoors and outdoors.
12. Hot overflow piping, indoors and outdoors.
13. Hot drain piping, indoors and outdoors.

B. Related Sections include the following:

1. Division 07 Section on penetration firestopping for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 21 Sections related to fire-suppression systems insulation.
3. Division 22 Section on plumbing piping insulation.
4. Division 23 Section on duct insulation for insulation for ducts and plenums.
5. Division 23 Section on HVAC equipment insulation for insulation materials and application for pumps, tanks, hydronic specialties, and other equipment.
6. Division 23 Section on hangers and supports for HVAC piping and equipment for pipe insulation shields and protection saddles.

1.2 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, vapor barrier, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Preformed Pipe Insulation Materials: 300 mm (12 inches) long by DN 50 (NPS 2).
2. Sheet Form Insulation Materials: 300 mm (12 inches) square.
3. Jacket Materials for Pipe: 300 mm (12 inches) long by DN 50 (NPS 2).
4. Sheet Jacket Materials: 300 mm (12 inches) square.

D. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

1.3 QUALITY ASSURANCE

A. Installer Qualification: Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products listed and labeled in accordance with UL 723 or in accordance with ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation and/or Jackets Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation and/or Jackets Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Project Director. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 3-m (10 foot) section of DN 50 (NPS 2) straight pipe.
b. One each of a 90-degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. One DN 50 (NPS 2) or smaller valve, and one DN 65 (NPS 2-1/2) or larger valve.

e. Four support hangers including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.
j. One Outside Air pick-up points
k. One water meter

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Project Director/COR 14 days in advance of dates and times when mockups will be constructed.
4. Obtain Project Director/COR approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Project Director/COR specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

D. Insulation work is subject to inspection by the Project Director/COR during installation and at commissioning for compliance with drawing and specifications. Deficiencies shall be corrected before acceptance by the government.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Project Director may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means.

B. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable).

C. Insulation packages and containers shall be asbestos free.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section on "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in the Part 3 Schedules for "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" for locations where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process. Comply with requirements in Part 3 Articles on SCHEDULE for locations where insulating materials shall be applied.

F. Calcium Silicate:

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

a. Johns Manville

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in the Part 2 Article on FACTORY-APPLIED JACKETS.

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. Pittsburgh-Corning (as FOAMGLAS) with PITTCOTE 300 coating

2. Block Insulation: ASTM C552, Type I.
3. Special-Shaped Insulation: ASTM C552, Type III.
4. Board Insulation: ASTM C552, Type IV.

5. Preformed Pipe Insulation without Jacket: Comply with ASTM C552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied **ASJ-SSL**: Comply with ASTM C552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C450 and ASTM C585.

H. Flexible Elastomeric Cellular Insulation Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II. Type I, Grade 1 for tubular materials. Type II, Grade 1, for sheet materials.

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. Aeroflex USA
   b. Armacell LLC
   c. K-Flex USA

2. Type I and II shall have vapor retarder/vapor barrier skin on one or both sides of the insulation and require an additional exterior vapor retarder covering for high relative humidity and below ambient temperature applications.
3. Contact Adhesive: Provide Contact Adhesive per insulation manufacturer's requirements. Apply Contact adhesive for all end seams and longitudinal seam.
4. Ultraviolet-Protective Coating: Apply to exterior locations. Provide UV Coating recommended by insulation manufacturer.
5. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
6. Flexible Elastomeric and Polyolefin Adhesive: Comply with SCAQMD Rule 1168.

7. Flexible Elastomeric Fittings: Fittings are factory prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible

elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, properly installed protective vapor retarder/barriers and vapor stops shall be used on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type **[I] [II with factory-applied vinyl jacket] [III with factory-applied FSK jacket] [III with factory-applied FSP jacket]**. Factory-applied jacket requirements are specified in the Part 2 Article on FACTORY-APPLIED JACKETS."

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. Johns Manville
   b. CertainTeed Corporation
   c. Knauf Insulation
   d. Owens Corning
   e. Manson Insulation

J. Mineral-Fiber, Preformed Pipe Insulation:

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. Johns Manville
   b. Manson Insulation
   c. Knauf Insulation
   d. Owens Corning

2. Type I, 454 deg C (850 deg F) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A,. Factory-applied jacket requirements are specified in the Part 2 Article on FACTORY-APPLIED JACKETS.
3. Type II, 649 deg C (1200 deg F) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A,. Factory-applied jacket requirements are specified in the Part 2 Article on FACTORY-APPLIED JACKETS.

K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ-SSL complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 40

kg/cu. m (2.5 lb/cu. ft.) or more. Thermal conductivity (k-value) at 55 deg C (100 deg F) is 0.042 W/m x K (0.29 Btu x in./h x sq. ft. x deg F) or less. Factory-applied jacket requirements are specified in the Part 2 Article on FACTORY-APPLIED JACKETS.

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. Johns Manville
   b. Manson Insulation
   c. Knauf Insulation
   d. Owens Corning

M. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. Johns Manville
   b. Dow

2. Comply with ASTM C591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.027 W/m x K (0.19 Btu x in./h x sq. ft. x deg F) at 75 deg F (24 deg C) after 180 days of aging.
3. Fabricate shapes according to ASTM C450 and ASTM C585.
4. Factory-Applied Jacket: Requirements are specified in the Part 2 Article on FACTORY-APPLIED JACKETS.

   a. Pipe Applications: **[ASJ][ASJ-SSL][PVDC][PVDC-SSL]**.

N. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534 or ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. Armacell

O. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.038 W/m x K (0.26 Btu x in./h x sq. ft. x deg F) after 180 days of aging. Fabricate shapes according to ASTM C450 and ASTM C585.

1. Available manufacturers: Subject to conformance with requirements, manufacturer offerings products that may be incorporated into this work include but are not limited to:

   a. DuPont

2.2 INSULATING CEMENTS

A. Materials shall be approved for use by cement manufacturer.

B. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

C. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

D. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Materials shall be approved for use by adhesive manufacturer.

C. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 10 to 427 deg C (50 to 800 deg F).

D. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 73 to plus 93 deg C (minus 100 to plus 200 deg F).

E. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 59 to plus 149 deg C (minus 75 to plus 300 deg F).

F. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

G. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

H. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of 29 to plus 60 deg C (minus 20 to plus 140 deg F).

I. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

J. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Materials shall be approved for use by mastics and coating manufacturer.

C. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 29 to plus 82 deg C (Minus 20 to plus 180 deg F)

3. Comply with MIL-PRF-19565C, Type II, for permeance requirements with supplier listing on DOD QPD (Qualified Products Database).
4. Color: White

D. Vapor-Retarder Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 18 to plus 82 deg C (0 to 180 deg F).
3. Color: White

E. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 46 to plus 104 deg C (Minus 50 to plus 220 deg F).
3. Color: White

F. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM E96, greater than 0.66 metric perms (1.0 perm) at manufacturer's recommended dry film thickness.
2. Service Temperature Range: Minus 29 to plus 82 deg C (Minus 20 to plus 180 deg F).
3. Color: White

2.5 LAGGING ADHESIVES

A. Materials shall be approved for use by adhesives manufacturer.

B. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
2. Service Temperature Range: Minus 18 to plus 82 deg C (0 to plus 180 deg F).
3. Color: White.

2.6 SEALANTS

A. Materials shall be approved for use by sealant manufacturer.

B. Cellular-Glass, Phenolic, and Polyisocyanurate Joint Sealants:

C. Polystyrene Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 73 to plus 149 deg C (Minus 100 to plus 300 deg F).
4. Color: White

D. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 121 deg C (Minus 40 to plus 250 deg F).
4. Color: Aluminum.

E. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 121 deg C (Minus 40 to plus 250 deg F).
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Materials shall be approved for use by jacket manufacturer.

B. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
2. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

3. PVDC Jacket for Indoor Applications: 0.10 mm (4 mil) thick, white PVDC biaxially oriented barrier film with a permeance at 0.013 metric perm (0.02 perm) when tested according to ASTM E96/E96M.
4. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
5. Vinyl Jacket: White vinyl with a permeance of 0.86 metric perms (1.3 perms) when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 68 g/sq. m (2 oz./sq. yd.) with a thread count of 4 strands by 4 strands/sq. mm (10 strands by 10 strands/sq. in.) for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 34 g/sq. m (1 oz./sq. yd.) with a thread count of 4 strands by 4 strands/sq. mm (10 strands by 10 strands/sq. in.), in a Leno weave, for pipe.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 271 g/sq. m (8 oz./sq. yd.).

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.

2. Color: White
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209M, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications**: [0.025 mm (1 mil) thick, heat-bonded polyethylene and kraft paper] [0.075 mm (3 mil) thick, heat-bonded polyethylene and kraft paper] [0.063 mm (2.5 mil) thick polysurlyn]**.
d. Moisture Barrier for Outdoor Applications: **0.075 mm (3 mil)** thick polysurlyn.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.

7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.

a. Factory cut and rolled to size.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: **[0.025 mm (1 mil) thick, heat-bonded polyethylene and kraft paper][0.075 mm (3 mil) thick, heat-bonded polyethylene and kraft paper][0.063 mm (2.5 mil) thick polysurlyn]**.
d. Moisture Barrier for Outdoor Applications: **0.075 mm (3 mil)** thick polysurlyn.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 3.2 mm (125 mil) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

F. PVDC Jacket for Indoor Applications: 0.10 mm (4 mil) thick, white PVDC biaxially oriented barrier film with a permeance at 0.013 metric perms (0.02 perms) when tested according to ASTM E96/E96M.

G. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.11 TAPES

A. Materials shall be approved for use by tape manufacturer.

B. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 75 mm (3 inches).
2. Thickness: 0.29 mm (11.5 mil).
3. Adhesion: 1.0 N/mm (90 ounces force/inch) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 7.2 N/mm (40 lbf/inch) in width.

6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 75 mm (3 inches).
2. Thickness: 0.16 mm (6.5 mil).
3. Adhesion: 1.0 N/mm (90 ounces force/inch) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 7.2 N/mm (40 lbf/inch) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

D. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 50 mm (2 inches).
2. Thickness: 0.15 mm (6 mil).
3. Adhesion: 0.7 N/mm (64 ounces force/inch) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 3.3 N/mm (18 lbf/inch) in width.

E. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 50 mm (2 inches).
2. Thickness: 0.093 mm (3.7 mil).
3. Adhesion: 1.1 N/mm (100 ounces force/inch) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 6.2 N/mm (34 lbf/inch) in width.

F. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 75 mm (3 inches).
2. Film Thickness: 0.10 mm (4 mil).
3. Adhesive Thickness: 0.04 mm (1.5 mil).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 10.1 N/mm (55 lbf/inch) in width.

2.12 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, **[Type 304][Type 316]**; 0.38 mm (0.015 inch) thick, **19 mm (3/4 inch)** wide with **[wing seal][or][closed seal]**.
2. Aluminum: ASTM B209M, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.51 mm (0.020 inch) thick, **19 mm (3/4 inch)** wide with **[wing seal][or][closed seal]**.

B. Wire: 1.6 mm (0.062 inch) soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation and/or adhesive application.

B. For Chilled Water Piping installed below grade and at exterior locations prepare surface of pipe to remove rust and contaminants. Apply two-part epoxy coating recommended by manufacturer.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various Part 3 Articles on pipe insulation material installation.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 50 mm (2 inches) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 300 mm (12 inch) intervals and tighten bands without deforming insulation materials.

2. Install two-layer insulation with joints tightly butted and staggered at least 75 mm (3 inches). Secure inner layer with wire spaced at 300 mm (12 inch) intervals. Secure outer layer with stainless-steel bands at 300 mm (12 inch) intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 25 mm (1 inch). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 150 mm (6 inches) on center
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 25 mm (1 inch), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 150 mm (6 inches) on center.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 25 mm (1 inch), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 38 mm (1½-inch) thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 INSTALLATION OF POLYSTYRENE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, and make thickness same as adjacent pipe insulation, not to exceed 38 mm (1½ inch).
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 50 mm (2-inch) overlap at seams and joints.
2. Embed glass cloth between two 1.6 mm (0.062 inch) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 38 mm (1½ inch) laps at longitudinal seams and 75 mm (3 inch) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 25 mm (1 inch) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 50 mm (2 inch) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 300 mm (12 inches) on center and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.

2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 50 mm (2 inches) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 850 mm (33-1/2 inches) or less. The 850 mm (33-1/2 inch) circumference limit allows for 50 mm (2 inch) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.12 INSTALLATION OF FIELD-APPLIED JACKET

A. Install PVC at minimum in all mechanical room and exposed ceilings with 50 mm (2 inch) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal longitudinal and butt end joints as indicated in the Part 3 schedule tables, or with weatherproof sealant recommended by jacket manufacturer. Secure metal jackets with stainless-steel bands 300 mm (1 foot) on center and at end joints.

B. Install metal jackets at minimum in all outdoor application including areas under canopies, parking garages, and any other areas indirectly exposed to outdoor with 50 mm (2 inches) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal longitudinal and butt end joints as indicated in the Part 3 schedule tables, or with weatherproof sealant recommended by jacket manufacturer. Secure metal jackets with stainless-steel bands 300 mm (1 foot) on center and at end joints.

3.13 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 Sections on "Exterior Painting" and "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

   a. Finish Coat Material: Interior, flat, latex-emulsion size.

2. Refer to Division 09 Section on “Exterior Painting” for exterior applications.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Project Director/COR. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.14 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Drainage piping located in crawl spaces, unless otherwise indicated.
5. Chrome-plated pipes and fittings, unless potential for personnel injury.
6. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.15 FIELD QUALITY CONTROL

A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:

1. Inspect fittings and valves randomly selected by Project Director/COR
2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work identified during these inspections and replace with new materials according to these Specifications.

C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.16 ACCEPTANCE

A. Following a minimum of 90 days operation (or installation), but no later than one year (and prior to project warranty expiration date), the Project Director/COR may inspect installation. This inspection may involve the use of advanced monitoring technologies such as Infrared Imaging or Ultrasonic mapping. Deficiencies identified during these inspections shall be corrected by Contractor prior to acceptance of facility by the Government, and prior to project warranty expiration.

3.17 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to Table 3.17-1 and Table 3.17-2 insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

SCHEDULES OF PIPE INSULATION, VAPOR RETARDERS, AND JACKETS FOR HVAC PIPING

TABLE 3.17-1 - HVAC PIPE INSULATION SCHEDULE

(See Notes 1 and 6)

PIPING SYSTEM & OPERATING TEMPERATURE	NOM. PIPE SIZE	INSULATION CHARACTERISTICS		VAPOR RETARDER (See Note 2)
		MATERIALS	MINIMUM THICKNESS	
CHILLED WATER, 4 -24°C (40-75°F)	Under DN38 (<1½")	Closed-Cell Cellular Glass (see note 8) Polyolefin, Polystyrene, or Elastomeric (See Notes 3 and 4)	12mm (1/2")	None. See Table 230719-2
	DN38 (1½") and larger		38 mm (1½")	
HEATING WATER & STEAM CONDENSATE (INDOOR) Up to 93°C (200°F)	Under DN38 (<1½")	Cellular Glass (see note 8), or Elastomeric	38 mm (1½")	FSK or ASJ With Taped Joints (See Note 5)
	DN 38 (1½") and larger		50 mm (2")	
DUAL TEMP. WATER SYSTEMS 4-93°C (40-200°F)	Same as Heating Hot Water	Same as Chilled Water	Same as Heating Hot Water	Same as Chilled Water
REFRIGERANT SUCTION AND HOT-GAS PIPING (INDOOR)	Under DN38 (<1½")	Closed-Cell Plastic Foams: Polyolefin, Polystyrene, Or Elastomeric (See Notes 3 and 4)	12 mm (1/2")	None. See Table 230719-2
	DN38 (1½") and larger		38 mm (1½")	

PIPING SYSTEM & OPERATING TEMPERATURE	NOM. PIPE SIZE	INSULATION CHARACTERISTICS		VAPOR RETARDER (See Note 2)
		MATERIALS	MINIMUM THICKNESS	
REFRIGERANT SUCTION AND HOT-GAS PIPING (OUTDOOR),	DN15-DN38 (½" - <1½")	Closed-Cell Plastic Foams: Polyolefin, Polystyrene, or Elastomeric (See Notes 3 and 4)	12mm (1/2")	None. See Table 230719-2
	DN38 (1½")		38 mm (1½")	
CONDENSER WATER -SUPPLY AND RETURN (free cooling applications)	ALL	Cellular Glass (see note 8) or Elastomeric	25 mm (1")	None
CONDENSER WATER – SUPPLY AND RETURN (OUTDOOR) (Free cooling applications)	ALL	Cellular Glass (see note 8) or Elastomeric	50mm (2")	None
STEAM 100 kPa (15 psig). Up to 177°C (350°F)	* DN20 (3/4")	Calcium Silicate or Cellular Glass (see note 8)	50 mm (2")	FSK or ASJ with Taped Joints (See Note 5)
	≥DN25 (1")		75 mm (3")	
MP STEAM 340 kPa (50 psig). above 177°C (350°F)	< DN20 (3/4")	Calcium Silicate Or Cellular Glass (see note 8)	75 mm (3")	FSK or ASJ with Taped Joints (See Note 5)
	>DN25(1")		100 mm (4")	
	] DN37 (1½")		114 mm (4½")	
EQUIPMENT DRAINS, ROOF DRAINS, & PLUMBING VENTS (See Note 7)	ALL	Elastomeric	19mm (3/4")	None
A/C CONDENSATE DRAINS 4 - 24°C (40 - 75°F)	ALL	Cellular Glass (see note 8) or Elastomeric	19mm (3/4")	None

PIPING SYSTEM & OPERATING TEMPERATURE	NOM. PIPE SIZE	INSULATION CHARACTERISTICS		VAPOR RETARDER (See Note 2)
		MATERIALS	MINIMUM THICKNESS	
UNDERGROUND PIPING, ALL SYSTEMS 4 - 140°C (40 - 300°F)	ALL	Pre-Manufactured, Pre-Insulated pipe and fittings, including injection polyurethanes w/ external non-metallic jacket	Refer to specific service above for insulation thickness	None
ENGINE EXHAUST PIPE, > 60º C (140ºF) ALL INTERIOR, and EXTERIOR less than 2.1m (7 ft) above ground.	ALL	Mineral fiber, fiberglass, high-temperature insulation wools (HTIW), refractories aluminum and calcium silicate.	As required for max outer surface temperature of 60ºC (140ºF) (ref ASTM C-1055)	None

Notes to Table 3.17 – 1

(1) For piping or conditions not included in this table, insulation thickness shall comply with 10 CFR 433 (ASHRAE Std. 90.1), this Specification Section, OSHA regulations, or common U.S. practice.
(2) Vapor Retarder does not include exterior jacketing; see Table 230719 – 3.12-2 for jacket requirements.
(3) Polyisocyanurate insulations are approved only for factory-injected pre-insulated piping.
(4) For all extruded foams, seal butt and longitudinal seams with adhesive, factory applied pressure sensitive adhesive (PSA), or other methods specified by the insulation manufacturer.
(5) FSK means foil, scrim, kraft paper facing; ASJ means foil-backed all-service jacket.
(6) The table does not apply to fire systems piping.
(7) As necessary in local conditions, insulate equipment drains, roof drains, drain bodies, drain overflows, and plumbing vents to control condensation in finished spaces. Separate Division 22 Section addresses pipe insulation in plumbing systems.
(8) Minimum thickness recommended for cellular glass insulation is 40 mm (1.5 inches). The reason is that the breakage rate during shipment of 25 mm (1inch) thick cellular insulation is too high to be economical.

TABLE 3.17 -2 - HVAC PIPE JACKETING SCHEDULE

PIPE SYSTEM	SERVICE LOCATION	NOM. PIPE SIZE	VAPOR RETARDER	INSULATION JACKET
ENGINE EXHAUST	All Interior; and all Exterior < 2.1m (7 ft) above ground or pavement.	ALL	NONE	Same as "Exterior, Including Rooftop"
EQUIP DRAINS, ROOF DRAINS, & PLUMBING VENTS	ALL	ALL	NONE	NONE
ALL EXCEPT ABOVE	Interior – Exposed, including Mechanical Rooms and raised accessible floors (See Note 1)	ALL	See Table 230719-1 above	0.5 mm (20-Mil) PVC with Molded Fittings, White In Color, Joints Glued Or Solvent Welded Joints
ALL EXCEPT ABOVE	Interior – Concealed by Wall, Ceiling, Soffit, Chase, etc.	ALL	See Table 230719-1 above	None
ALL EXCEPT ABOVE	Exterior, Including Rooftop (See Note 2 & 3)	ALL	See Table 230719-1 above	0.5 mm (20-Mil) Stainless Steel with Molded Fittings and 0.5 mm x 19 mm (0.020" x 0.75") SS Bands; Joints Sealed Watertight w/ 25-Year RTV Silicone, Clear or Silver in Color, No Tapes **[or 3003 H-14 Aluminum,0.4 mm (0.016") Thick, w/ Pre-formed Fittings, and 0.5 mm x 19 mm (0.020" x 0.75") Alum Bands; Joints Sealed Watertight with 25-Year RTV Silicone, Clear or Silver in Color, No Tapes]**

PIPE SYSTEM	SERVICE LOCATION	NOM. PIPE SIZE	VAPOR RETARDER	INSULATION JACKET
ALL	Underground	ALL	Only Pre-Insulated and Pre-Jacketed Pipe and Fittings Manufactured Specifically for Underground use. Exceptions by Approval Only	

Notes to Table 3.17 – 2

(1) "Interior" means any piping within the envelope of building or structure.
(2) "Exterior" means any piping outside envelope of building or otherwise exposed to weather; exterior piping which is concealed or under cover is Exterior pipe.
(3) Tapes shall not be used on exterior piping, including rooftop locations.

END OF SECTION 230719

SECTION 230805 – COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment, which may include but not limited to the following:

1. Energy supply systems, including oil supply, central-plant hot-water supply, and solar-energy supply.
2. Heat generation systems, including hot-water boilers and auxiliary equipment.
3. Cooling generation systems, including chilled-water systems direct-expansion systems.
4. Distribution systems, including air distribution (heating and cooling) systems, hot-water distribution systems, glycol distribution systems, chilled-water distribution systems, exhaust systems, and air-handling units.
5. Terminal and packaged units, including unit ventilators, unit heaters, fan-coil units, finned-tube radiation, and electric heating.
6. Split systems, heat pumps, and variable refrigerant flow systems.
7. Vibration and sound systems, including sound attenuation, sound masking, vibration isolation devices and seismic restraints.
8. Controls and instrumentation, including building automation systems (BAS), energy monitoring and control system.
9. Systems testing and balancing verification, including heating-water piping systems chilled-water piping systems domestic hot-water circulating systems supply-air systems return-air systems exhaust-air systems.

B. Related Sections:

1. Section 019115 “Commissioning” identifies general commissioning processes and procedures, as well as roles and responsibilities for all Commissioning Team members. Section 230805 supplements the general requirements specified in Section 019115.
2. Applicable provisions of each Division 23 Section and Division 01 apply to this Section.

1.2 REFERENCES AND STANDARDS

A. References and Standards as required by each Division 23 Section, and by Division 01 Sections in relation to commissioning activities.

B. In addition, conform to the following:

1. ASHRAE Guideline 0, The Commissioning Process.
2. ASHRAE Guideline 1.1, HVAC&R Technical Requirements for The Commissioning Process

1.3 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

C. Qualification Data: For BAS and HVAC&R Testing Technician.

D. List of Test Equipment and Instrumentation: For each equipment or instrument, identify the information below. Include information for proprietary equipment/instrumentation in a separate list.

1. Equipment/instrument identification number. Identify equipment and instruments that are proprietary (i.e., from HVAC system/equipment manufacturer for use with associate system/equipment).
2. Planned commissioning application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

E. Plan and Final Report for Cleaning, Flushing, Testing, and Treating HVAC Piping: Identify the following information, and submit a copy to the Project Director/COR for inclusion in final commissioning report:

1. Sequence of testing and testing procedures for each Section of pipe to be tested, identified by pipe zone or sector identification marker. Markers keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test Section. Provide drawings keyed to pipe zones or sectors formatted to allow each Section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Provide plan for whole system flush after all zone flushes are complete. Indicate where filters are installed and how often system filters (permanent and temporary) are to be checked for contaminants.
5. Tracking checklist for managing and ensuring that pipe Sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

F. Plan and Reports for HVAC Testing, Adjusting and Balancing: Refer to Section 230593.

1. Provide weekly field copy of testing and balancing results to Project Director and to CxA for review.

G. Test Results for Air Duct Testing: Refer to Div 23 Section for air duct testing.

1. Submit copy of test results to Project Director for CxA review prior to functional performance testing and for inclusion in final commissioning report.

1.4 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians supporting commissioning activities shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing and servicing the brand/line of controls being tested
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level II.

B. HVAC&R Testing Technician Qualifications: Technicians supporting commissioning activities shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with three years' experience in servicing HVAC&R mechanical systems or vocational school four-year program graduate with two years of experience in servicing HVAC&R mechanical systems.
2. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
3. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing and Balancing Technician Qualifications: Technician supporting commissioning activities shall have one of the following minimum qualifications:

1. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
2. Associated Air Balance Council (AABC) Certified Test and Balance Technician.

D. Testing Equipment and Instrumentation Quality and Calibration:

1. Test equipment and instrumentation shall conform to the following:

   a. Be capable of testing and measuring performance within the specified acceptance criteria.
   b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
   c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
   d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

2. Equipment Manufacturer's Proprietary Instrumentation and Tools:

   a. HVAC&R proprietary test instrumentation and tools shall become the property of Government at the time of Substantial Completion.

1.5 GOVERNMENT AND CXA RESPONSIBILITIES

A. Refer to Section 019115 "Commissioning" for a description of roles during commissioning.

1. Project Director/COR: The Project Director (or COR if no PD is actively involved in a project at any given time) has overall responsibility for Government oversight of projects.
2. CxA: The Commissioning Agent is the Government representative for commissioning, working under the Project Director.

1.6 COMMISSIONING DOCUMENTATION

A. Submittals as required by each Division 23 Section and by Division 01 in relation to commissioning.

1.7 GENERAL WARRANTY PROVISIONS

A. Commissioning, inspecting, and testing shall not modify terms or time periods of warranties for mechanical equipment, systems, and controls, including warranties for related equipment, systems, and adjacent work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Provide technicians, instrumentation, tools, and equipment to complete and document the following:

1. Start-up testing.
2. Prefunctional Checklist.
3. Functional Performance Testing.
4. Trending and logging test data.

B. Complete the following activities for each system/equipment prior to the start of functional performance testing:

1. Certify that HVAC&R systems, subsystems and equipment have been installed, calibrated, and started, and are operating according to the contract documents and approved Shop Drawings and submittals. Include this statement of certification on prefunctional checklist.
2. Certify that HVAC&R instruments and controls systems have been completed and calibrated, and that they are operating according to the contract documents and approved shop drawings and submittals, and that pretest set points have been recorded. Provide

control point-to-point checks and calibration records to the Project Director/COR one week prior to functional performance testing.

3. Certify that testing, adjusting and balancing procedures in Section 230593 ”Testing, Adjusting, and Balancing for HVAC” for the system and/or equipment have been completed, and that a preliminary/field copy of testing adjusting and balancing reports has been submitted to the Project Director/COR for review by the CxA one week prior to functional performance testing, discrepancies corrected and corrective work approved.
4. Certify that the following work has been completed in accordance with the Contract Documents, and that the equipment, systems, and sub-system are operating as required.

    a. Fire stopping in fire-rated construction, including installation of combination smoke/fire dampers, fire dampers, and smoke dampers, caulking, gasketing, and sealing of smoke barriers.
    b. Fire detection and smoke detection devices furnished in accordance with Section 284626 “Addressable Fire Alarm Systems.”

5. Certify that all building envelope work has been completed in accordance with the Contract Documents, including installation of permanent doors prior to functional testing.
6. Set systems, subsystems, and equipment into specific operating mode to be tested in accordance with approved test procedures (e.g., for normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
7. Inspect and verify position of each device and interlock identified on checklists.
8. Check safety cutouts, alarms, and interlocks with life safety systems during each mode of operation.
9. Testing Instrumentation: Install measuring instruments and logging devices to record test data as required.
10. Pipe System Cleaning, Flushing, Hydrostatic Tests, and Chemical Treatment: Refer to Division 23, HVAC piping Sections for test requirements.

3.2 GENERAL TESTING REQUIREMENTS

A. Commissioning will be provided in the following order:

1. Start-up testing
2. Prefunctional Checklist
3. Functional Performance Testing
4. Trending and logging test data.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

D. Test systems, assemblies, subsystems, equipment, and components in their normal automatic operating modes and then in stages to confirm operation of interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

E. Perform tests using design conditions, whenever possible. Complete appropriate initial performance tests and documentation and schedule seasonal tests (unless seasonal tests are not required).

1. Simulated conditions may, with approval of Project Director/COR, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Authority, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
4. When simulated conditions, set points, and and/or sensor values are approved it is the responsibility of the HVAC Contractor/Subcontractor to ensure altered values are returned to design set points. Any damage due to failure to return to design set point conditions is the responsibility of the Contractor.

F. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Project Director/COR. After deficiencies are resolved, reschedule tests.

END OF SECTION 230805

SECTION 230905 - INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes Building Automation System (BAS) control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following, but not limited to:

1. Section 117000 “Medical Equipment” for equipment such as **[Laboratory Fume Hood and]** pharmaceutical refrigerator temperature alarm.
2. Section 223230 “Potable Water Treatment.”
3. Water Booster Pumps, and Water Softeners, and other water treatment are specified in Division 22 sections.
4. Section 221500 “General Service Compressed Air System.”
5. Identification is specified in Division 23 Section on identification for HVAC system.
6. Section 230593 “Testing, Adjusting, and Balancing for HVAC.”
7. Section 230805 “Commissioning of HVAC.”
8. Hydronic and refrigerant piping are specified in Division 23 sections.
9. Computer Room Air Conditioning Unit and Water Leak Detection Systems are specified in Division 23.
10. Chillers, AHUs, VAVs and other mechanical equipment are specified in Division 23 sections.
11. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
12. Raceways/boxes are specified in Division 26 sections.
13. Section 260915 “Electric Power Monitoring.”
14. Section 260924 “Lighting Control Devices.”
15. Section 260934 “Centralized Dimming Controls.”
16. Section 262417 “Panelboards.”
17. Motor control centers are specified in Division 26 Section on motor control centers.
18. Variable Frequency Drives are specified in Division 26.
19. Section 263214 “Engine Generators.”
20. Network connections and signal/communications cable are specified in Division 27.
21. Section 284626 “Addressable Fire Alarm Systems.”
22. **[Section 333700 “Wastewater Treatment Plant.”]**
23. Section 335005 “Underground Fuel Storage Tanks and Distribution” for fuel monitoring.

1.2 SYSTEM DESCRIPTION

A. General: This Section includes Building Automation System (BAS) control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls. These control systems regulate building pressurization, temperature and humidity, CO_2 concentrations, and ventilation rates in thermostatic zones.

Additionally, control systems provide: Continuous monitoring of electric/fuel/water consumption at each building, AHU fan speeds, AHU entering and leaving air temperatures and filter pressure drops, hydronic water pressure drops as well as water flow rate, VAV and hydronic valve actual and minimum and maximum settings, equipment operations, automated starting/stopping for energy conservation and power failures. Energy consumption must be monitored and reported to end-user computer for entire compound, each individual building (e.g., office building, utility building), each AHU fan and each chiller on BAS.

1. Direct Digital Control (DDC) and/or electric/electronic controls are the OBO standard. In case of DDC network failure, redundancy requirements must permit local stand-alone operation of all HVAC systems. All digital controllers must be able to fully operate without network connectivity.
2. All I/O points specified for the control of a specific piece of equipment must be integral to a single controller. The following are examples of how this must be implemented:

    a. Provide one dedicated Digital Controller per Air Handling Unit (AHU). Use of multiple controllers to control a single AHU or multiple AHUs controlled by a single controller is not permitted.
    b. Provide one dedicated Terminal Unit Controller, designed specifically for control of that Terminal Unit (e.g., for each VAV box, for each fan coil unit). Control of multiple Terminal Units by a single controller is not permitted.
    c. Connect end of system differential pressure sensor directly to controller of system that is controlled by its signal.

3. Controllers must be stand-alone and independent of Operator’s Workstation (OW) and other controllers. Failure of an OW or an individual controller must not inhibit operation or program execution of other controllers in the BAS.

    a. All physical input and output points specified for a given piece of equipment must be terminated to a single controller.
    b. All programming specified for a given piece of equipment must reside in the respective controller, not in an OW or another unassociated controller.
    c. Primary input and output of each control loop must be resident in the same controller containing the control algorithm and must function independently of peer or mux communication links. Secondary or reset type, inputs may be received from the network, but approved default values and procedures must be substituted in the control algorithm for these secondary inputs if network communications fail or input becomes erroneous.

4. Incorporate sufficient space in control panels, conduit, and associated controls equipment for future expansion of control point capacity by up-to 25 percent. This must include space for wire, I/O modules, terminal blocks, transformers, and similar components.
5. Systems are required to operate under automatic control any time equipment status is 'On'. All Digital Controllers must be able to fully operate controlled equipment when placed in HAND or AUTO modes of operation. Digital Controllers must monitor operation of equipment for manual override and must control equipment according to sequence of operation when overridden (i.e., if an AHU supply fan is placed into ‘HAND Mode’, then

rest of AHU must operate in automatic operation). Sequence of operation must reflect this requirement.

6. Sequence of Operation must include the following modes of operation:

   a. Occupied/Normal
   b. Unoccupied/Setback/Low-Flow
   c. Lead/Lag Rotation
   d. Emergency Operation
   e. Alarms.

7. HVAC equipment and controls must automatically restart after power disruptions. BAS must automatically restart control sequences without need for manual intervention. Each VFD must be delayed five seconds as each unit comes online and must have slow ramp up. If this requires the inclusion of UPS equipment, then it must be provided, installed and tested as required by this section subcontractor.

B. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems. Main or front-end personal computer (PC) and printers must serve only non-Controlled Access Area (non-CAA) spaces and must be located in dedicated BAS room with controlled access and must provide central control over all non-CAA HVAC equipment. Provide three portable laptop PCs complete with operating system licenses, graphics software (with developed site-specific graphics), and as-built BAS programming: one PC for non-CAA use and two identical PCs for CAA/PCC use. Both the CAA and PCC laptops must be equipped with all software necessary for either laptop to be able to service or interface with both the CAA and PCC BAS systems. Securely store laptops for CAA and PCC during construction and turn over to Project Director/COR at end of construction. Forward selected subset of alarms, as either indicated on construction documents or directed by Project Director/COR, concurrently to HMI panel at Post 1 for after-hours supervision.

C. There must be no direct inter-connectivity between control wiring and equipment located in CAA spaces and controllers in non-CAA spaces. Control circuits serving non-CAA spaces must not traverse into CAA space.

D. Do not install modems on PCs that monitor HVAC equipment. PCs that contain building monitoring software must not be accessible to Internet. Network Connections to central monitoring computer must be in accordance with Division 27. At minimum, install wiring or cables in dedicated signal conduits or telecom raceway.

E. Prohibited Technologies:

   1. The use or inclusion of wireless communication technology is not permitted.
   2. The use or inclusion of cameras and other types of image / video capture technology is not permitted.
   3. The use or inclusion of microphones and other types of sound capture technology is not permitted.

4. In situations where hardware cannot be procured without the inclusion of one or more of the prohibited technologies listed above, then the associated capabilities must be rendered inoperable.

F. Provide programming for sensors (e.g., temperature, humidity, pressure), AHUs and VAV boxes within CAA space at each component using direct digital controllers. CAA space equipment must not allow the central non-CAA BAS system to control units such as AHUs, VAV, and FCUs located in CAA space. The controllers within the CAA may be networked (with exception to core suites). However, the CAA BAS network must not traverse the CAA physical boundary. The CAA BAS network must not be connected to the non-CAA BAS systems or controllers outside of the CAA. Provide a panel mounted user-interface (in addition to the CAA laptop) in a convenient but secure location within the CAA for interfacing with the DDC controllers in CAA.

G. Control system must collect data necessary to provide detailed reports for power consumption and energy review. Obtain power consumption data from electrical power monitoring system via mapping of selected Owner approved points available via third-party interface; see Section 260915 "Electrical Power Monitoring." Data for consumption (kW) usage (kWh), voltage (V) and power factor (pf) must provide daily, monthly and annual consumption, highs, lows and averages. Reports must provide data for fuel consumption (liters), natural gas (m3), outside ambient temperatures (deg C), relative humidity (percent), and water consumption (liters) for each building on compound, and for photovoltaic system provided power (kW) when system is required in contract. Provide reports for major individual feeders for buildings. Reports must be provided on monthly basis via system software. Provide data in digital formats, capable of data mining. Maintain data in format which can provide required reports for minimum of five years (first year plus four consecutive years).

H. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

1. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
3. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
4. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
5. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
6. Performance: Programmable controllers must execute DDC PID control loops, and scan and update process values and outputs at least once per second.
7. Reporting Accuracy and Stability of Control: Report values and maintains measured variables within tolerances identified in Part 2 of this Section.

1.3 SYSTEM PERFORMANCE

A. General: System design must conform to OBO Mechanical Code (International Mechanical Code as amended by OBO).

B. Provide a complete and functional BAS in accordance with the Issued For Construction (IFC) Documents. It is the responsibility of the controls subcontractor to create detailed DDC points list, control sequences, and control system strategy write up that will achieve stable control performance together with thorough and complete system monitoring; these must be agreed to and approved by the Engineer of Record and by the Project Director/COR with input from the OBO/PDCS/DE project team BAS Subject Matter Expert (SME) and the project Commissioning Agent.

1.4 SUBMITTALS

A. General:

1. Each submittal must be complete in every respect and must be submitted as one complete package with a traceable number. Partial submittals will be rejected without review. The following submittal packages are required by this project:

   a. Construction Submittal (BASSUB-1)
   b. Training Submittal (BASSUB-2)
   c. Field Quality Control Submittal (BASSUB-3)
   d. Record Documentation Submittal (BASSUB-4)

2. BAS submittals must be divided into three completely separate packages using different transmittal protocols as required for security, with separate packages for non-CAA, CAA, and PCC security zones. Label submittal documents in accordance with Division 01 specification sections.
3. After the initial submittal, subsequent submittal versions must each include a unique revision number. Updates in revised submittals must be clouded with the revision number. Revisions packages of each security zone must also be complete for the respective zone.
4. First submittal must be discussed in detail during Controls Integration Meeting specified in QUALITY ASSURANCE, with OBO comments on the submittal incorporated into the subsequent submittal.

B. Construction Submittal (BASSUB-1): Prior to the commencement of BAS work, both the procurement of materials and installation, a Construction Submittal must be provided for review and approval. A complete Construction Submittal must consist of all the drawings, product data and other information required below. Omission of any of these items, including work specified within this Section but performed by a contractor other than the BAS sub-contractor, will constitute an incomplete submission and will not be reviewed. Upon approval of the Construction Submittal, procurement and installation of the BAS will be permitted to commence. Any procurement or installation that occurs prior to approval of the Construction Submittal will be performed at the Contractor's own risk.

1. Product Data: Technical Literature from product manufacturers will be submitted for each unique product that is intended for use on the project.

a. General:

1) Comprehensive Bill of Materials: Product Data submitted will include a Bill of Materials in a tabular format that will act as a Table of Contents. A row will be included for each product. Columns shall be included to provide the following information: Device Name, Quantity, Complete Model / Part Number, Product Description, Manufacturer, Specification Reference, and Page Number of the associated Technical Literature.
2) Page Numbering: All pages of the submitted Product Data will be sequentially numbered. (1, 2, 3, 4…) The page numbering in the Bill of Materials will be coordinated to ensure the correct page numbers are used. Page numbers must be printed on each page of Technical Literature.
3) Marking of Products: When submitted literature refers to a series of products or multiple products rather than a specific product model, data specifically applicable to the project will be highlighted and clearly annotated. Mark literature to indicate the specific model, associated options and accessories intended for use.
4) Specification References: Each submitted piece of literature will be annotated to clearly cross reference the specification requirement that the submitted product is intended to cover. If a product is not specified, note that no specified requirement exists for the submitted product.

b. Technical Literature: Submit literature from the product manufacturer that provides a product description and technical data, that indicates dimensions, capacities, performance characteristics / curves, electrical characteristics, finishes for materials, etc., to show compliance with the specified requirements. Installation and startup instructions for each type of product will also be included. Submitted literature will be organized into the following sections.

1) Parts: Description, intended use and technical data for sensors, devices, ancillary components, wire, cable, installation materials, etc.
2) Controller Hardware: Description, intended use and technical data for BAS manufacturer's controllers, expansion modules, communication interfaces and other control system hardware. Provide a Protocol Implementation Conformance Statement (PICS) for each BACnet based control device submitted.
3) Computers & Network Hardware: Description, intended use and technical data for servers, desktop computers, laptop computers, computer peripherals, touchscreens, interfaces, switches, routers, security appliances and other network equipment. Provide a PICS for each BACnet based network device submitted.
4) Software: Description, intended use and technical data for BAS programming software, BAS operator interfaces, BAS color graphics, operating system software, productivity software and other third-party applications. Provide a PICS for each BACnet based software package submitted.
5) Licenses:

a) Submit licensing information for all software installed on servers, desktop computers, laptop computers, touchscreens and other interfaces.
b) Submit licensing information for all hardware that requires licensing. (network level controllers, managed switches, security appliances, etc.).

2. Shop Drawings:

a. Provide legend for all symbols used.
b. System Architecture Diagrams

1) Riser diagram showing IP layer and all field bus layers.

2) Show each computer, printer, router, repeater, controller, and protocol translator that is connected to either the IP layer or any of the field busses.
3) Each component that is shown must have a name that is representative of how it will be identified in completed database and manufacturer's name and model number.
4) Physical relationship of one component to another component must reflect proposed order of installation on network.
5) This diagram must not include power supplies, UPS, sensors or end devices.
6) Show separation of unclassified BAS from CAA.
7) Identify third-party interface wiring type, communications protocol and locations.
8) Field Bus must clearly show use of daisy chain wiring concept, order in which devices are connected to Field Bus, and location of end of segment termination devices.
9) Show BAS communications bus campus routing between buildings and indicate location and tagging information of terminal blocks with detail references.

c. BAS Plan Drawings: Drawings must be submitted that depict the proposed installation locations for components and infrastructure specific to the BAS.

1) General:

a) Plan drawings must be drawn to scale. Scale must be selected as appropriate to clearly depict required information. Scale must be noted on each plan drawing.
b) Building designations and room numbers must be shown on plan drawings.
c) Equipment designations must be shown on plan drawings.
d) Controllers, enclosures, sensors, network components, etc. shown on plans must be annotated with their associated designations and component types. Designations must match those used throughout submittal.

e) Where infrastructure shown crosses the bounds of a plan drawing, the continuation point must be clearly annotated to indicate the drawing and detail where the continuation can be found.
f) Plans to be submitted are in addition and complimentary to coordination drawings that are to be submitted under other specification sections. The purpose of these plans is to provide specific information related to the installation of BAS components and infrastructure. This information is required to provide a complete picture of the proposed BAS installation and is necessary to ensure a complete, fully functional and issue free BAS will be provided that meets the requirements of this specification section.
g) Site and floor plan drawings must be continually updated and maintained accurately throughout the construction period. These drawings must be an active record that accurately reflects installed conditions as the project progresses and must be available upon request by anyone inspecting the BAS installation on behalf of OBO.

2) Building Floor Plan Drawings (Network): Drawings must indicate the following information.

a) Proposed routing of network cable and associated conduit, raceway and duct-bank. For each network segment identify:

i. Network Type (RS-485, Ethernet, etc.)
ii. Communication Protocol (BACnet MS/TP, BACnet IP, etc.)
iii. Physical Medium (multi-mode optical fiber, Cat 6, shielded twisted pair, etc.)
iv. Transmission Speed (baud rate)
v. Designation Assigned to Network

b) Locations of building entry points.
c) Locations of controllers and enclosures.
d) Locations of network components. (routers, switches, gateways, optical isolators, repeaters, security appliances, end-of-line resistors, junctions, grounding locations, building termination blocks, etc.)
e) Locations of Operator Work Stations, Servers, Touch Screen Interfaces and similar equipment.
f) Locations of equipment monitored / controlled by the BAS. (AHUs, FCUs, Terminal Units, etc.)
g) Locations of dampers. (Control, Smoke and Combination Fire/Smoke)
h) Locations of outdoor and space mounted sensors. (Temperature, Humidity, CO2, etc.)
i) Locations of control valves not co-located with controlled equipment.
j) Locations of meters and flow measurement sensors not co-located with controlled equipment.

3) Campus Site Plan Drawings (Network): Drawings must indicate the following information.

a) Proposed routing of network cable and associated conduit, raceway and duct-bank. For each network segment identify:

vi. Network Type (RS-485, Ethernet, etc.)
vii. Communication Protocol (BACnet MS/TP, BACnet IP, etc.)
viii. Physical Medium (multi-mode optical fiber, Cat 6, shielded twisted pair, etc.)
ix. Transmission Speed (baud rate)
x. Designation Assigned to Network

b) Locations of building entry points and duct-bank access points.
c) Locations of controllers and enclosures not identified on building floor plans.
d) Locations of network components not identified on building floor plans. (routers, switches, gateways, optical isolators, repeaters, security appliances, end-of-line resistors, junctions, grounding locations, building termination blocks, etc.)
e) Locations of meters and flow measurement sensors not identified on building floor plans.

4) Building Floor Plan Drawings (Pneumatic): Drawings must indicate the following information.

a) Proposed routing of pneumatic tubing and associated conduit, raceway and duct-bank. For each tubing section identify:

xi. Tubing type (copper, poly, etc.)
xii. Tubing size
xiii. Designation of Associated Sensor
xiv. Associated HVAC System (AHU, Relief Fan, etc.)

b) Locations of pressure sensors and associated pressure probes. Information associated with space pressure control, duct static pressure control and liquid differential pressure control must be shown.
c) Locations of controllers and enclosures associated with pressure sensors and pneumatic tubing.
d) Identify pressure zones and pressure differentials to be maintained between zones.
e) Identify set points being maintained by the BAS at each pressure sensor.

d. Layout Drawings for each control panel:

1) Layout drawing must be to scale with all devices shown in their proposed positions.
2) Identify all control devices by tag number.
3) Show all terminal strips and wire channels and fiber optic to copper cable converters.

4) Show all control transformers.
5) Show all power receptacles and power supplies (including panel and breaker numbers) coordinated with Division 26.
6) Show all IP connection points.
7) Identify designated allowance for future 25 percent expansion capacity.

e. Wiring Diagrams for each control panel.

1) Control voltage wiring diagram must clearly designate devices powered by each control transformer. If control devices use half wave power, diagram must clearly show consistent grounding of appropriate power connection. Annotate all wire identification numbers on diagram. When more than one controller is powered from single circuit, provide separate power fuses for each controller at respective control panel. Provide separation for control voltage wiring (24V AC or DC) from Power Voltage (110V or higher).
2) Annotate all wire identification numbers on diagram.
3) If shielded communication wiring is used, show grounding of shield.
4) Terminal strip wiring diagram must identify all connections on both sides of terminal strip. Annotate wiring label numbers for all wiring leaving control panel on diagram.

f. Wiring Diagrams for individual components (controllers, protocol translators, etc.): Wiring diagram for each component must identify all I/O, power, and communication wiring, and locations on terminal blocks to which wires are landed (e.g., Fan Status sensor is wired from terminals 5/6 on controller to terminals 17 and 18 on terminal strip).

g. Sensor / End Device Wiring Details:

1) Provide typical wiring details for each sensor and end device (including third party sensors, end devices and equipment) which shows the wiring terminated at the sensor / end device.
2) For sensors and end devices which can be wired up in multiple configurations, a unique detail must be provided for each configuration used.
3) Each detail must be complete, showing and identifying all terminals / wire leads.
4) Both used and unused terminals / wire leads must be shown to clearly depict how wiring will be installed at the sensor / end device.
5) Each detail must be provided with a unique ID. These IDs must be referenced in the wiring diagrams where the sensor / end device is used. Each ID must incorporate the drawing number of the Sensor / End Device Wiring Detail drawing where the detail is located.
6) Incorporate sensor / end device part numbers into detail titles.

h. Instrumentation List for each controlled system.

1) List must be in table format.

2) Include name, type of device, manufacturer, model number, and product data sheet number. Description to include if device is intended for plenum rating, indoor or outdoor installation, as well as fail-safe position.

i. System Flow Diagrams for each controlled system.

1) Two-dimensional cross-sectional diagram showing key components such as fans, coils, dampers, valves, and pumps.
2) Identify locations and names of all sensors and end devices associated with control system. Label panel name and terminal numbers where connections are landed.

j. Point Lists: Point lists must be provided for each unique system controlled / monitored.

1) A separate point list must be provided for each controller used. Only the points physically connected to the controller along with its associated expansion modules and points which are physically incorporated into the controller itself shall be included in the point list.
2) A separate point list must be provided for each communication interface used. Only the points provided over the communication interface shall be included in the point list.
3) Each line item included in a point list must represent only one point.
4) Point tags and point names used in a point list must be unique within that point list.
5) Point names and expanded point descriptions must incorporate the associated point tags used.
6) At a minimum, the following columns and information must be included in each point list:

a) Point Tag
b) Point Name
c) Expanded Point Description
d) I/O Type (AO, AI, BO, BI, etc.)
e) Point Address
f) Terminations at Controller
g) Control Signal (4-20mA, 0-10VDC, on/off, pulsed, etc.)
h) Range (with Units)
i) Alarm Required
j) Alarm Limits / Criteria
k) Alarm Priority (Maintenance, General, Critical)
l) Alarm to Post 1
m) Trend Required
n) Trend Type
o) Trend Interval
p) Device Type (Relay, Temperature Sensor, CO2 Sensor, Actuator, VFD, etc.)
q) Part Number

r) Part Manufacturer

k. Sequences of Operation: Provide sequence of operation for each system or piece of equipment being controlled. Include the following as a minimum.

1) Process control sequence for each end device.
2) Supervisory logic sequence of operation for each system.
3) Impact of each global application program on sequence of operation (e.g., Demand Control).
4) List of all physical inputs and outputs associated with each sequence.
5) Within sequence of operation, annotate all application parameters that are to be user-adjustable from Operator's Workstation (OW) with (adj) after name of parameter. This must include information such as set points, including upper/lower set point limits where applicable, reset schedule parameters, calibration offsets, timer settings, control loop parameters such as gain, integral time constant, sample rates, and differentials.
6) Within sequence of operation, annotate all calculated values that are to be viewable at the OWS with (rpt) after name.
7) All points subject to override from an operator workstation, including set point adjustments, start/stop, enable/disable, open/close.
8) List of all alarm points, description of alarm, and description of alarm criteria.
9) List of all variables for which historical trending will be applied, sample rates, and any criteria used to start and stop historical trending.

l. Pneumatic Tubing Riser Diagrams

1) Riser diagram showing pressure sensor locations, pressure probe locations, and pneumatic tubing.
2) Clearly identify rooms where components are located. Include tagging of sensor and probes. For each probe identify negative and positive probes.
3) Show and identify each unique pressure zone and indicate pressure being maintained in the zone based on the actual locations of the pressure probes for the associated sensor.

m. Valve Schedule: Provide valve schedule in a tabular format with a row for each valve used on the project. Columns shall be included to provide the following information:

1) Valve Service Tag
2) System Served (Designation of associated AHU, FCU, CHWS, HWS, etc.)
3) Installed Location (Building & Room)
4) Medium (CHW, HW, Steam, Glycol, etc.)
5) Valve Manufacturer
6) Valve Model / Part Number
7) Valve Style (2-way, 3-way, etc.)
8) Valve Type (ball, characterized control ball, globe, butterfly, etc.)
9) End Connection Type (threaded, flanged, soldered, welded, etc.)
10) Pipe Size (mm)
11) Valve Size (mm)

12) Design Flow Rate (l/s)
13) Design Pressure Drop (kPa)
14) Design Flow Coefficient (Kv)
15) Valve Pressure Drop (kPa)
16) Valve Flow Coefficient (Kv)
17) Close Off Pressure Rating (kPa)
18) Actuator Manufacturer
19) Actuator Model / Part Number
20) Control Signal (0-10 VDC, 4-20 mA, on/off, etc.)
21) Voltage (24 VAC, 120 VAC, etc.)
22) Control Action (2-Position, Modulating, etc.)
23) Torque (Nm)
24) Number of Actuators
25) Run Time (in seconds)
26) Failure Position (Loss of Power – Normally Closed, Normally Open or Last Commanded State)
27) Failure Position (Loss of Control Signal – Normally Closed, Normally Open or Last Commanded State)

n. Damper Schedule: Provide damper schedule in a tabular format with a row for each damper used on the project. Columns shall be included to provide the following information:

1) Damper Service Tag
2) System Served (Designation of associated AHU, FCU, CHWS, HWS, etc.)
3) Installed Location (Building & Room)
4) Service (Supply, Return, Outdoor, etc.)
5) Damper Manufacturer
6) Damper Model / Part Number
7) Blade Type (Airfoil / Opposed, V-groove / Parallel, etc.)
8) Damper Construction (Aluminum, Galvanized Steel, etc.)
9) Duct Size (mm)
10) Damper Size (mm)
11) Number of Damper Sections
12) Damper Section Size (mm)
13) Damper Free Area (mm2)
14) Maximum Air Flow (l/s)
15) Maximum Air Velocity (m/s)
16) Actuator Manufacturer
17) Actuator Model / Part Number
18) Control Signal (0-10 VDC, 4-20 mA, on/off, etc.)
19) Voltage (24 VAC, 120 VAC, etc.)
20) Control Action (2-Position, Modulating, etc.)
21) Torque Required (Nm)
22) Torque Provided (Nm)
23) Number of Actuators
24) Fully Loaded Run Time (in seconds)

25) Failure Position (Loss of Power – Normally Closed, Normally Open or Last Commanded State)
26) Failure Position (Loss of Control Signal – Normally Closed, Normally Open or Last Commanded State)

3. Certifications:

a. Compliance Certification: The Contractor and installing subcontractors must certify that the BAS, as installed, complies with the following restrictions:

1) The BAS does not utilize or include any prohibited technologies. Where hardware cannot be procured without the inclusion of a prohibited technology, indicate the following:

a) Product Name, Part Number & Part Description.
b) Manner in which product is being used.
c) Prohibited technology included.
d) Means & methods by which the capability has been rendered inoperable.
e) Attestation that product was tested after modification and base functionality has not been impacted.

2) The BAS has not been interconnected with any non-BAS networks.
3) The BAS has not been provided with remote connectivity.
4) The non-CAA, CAA-Restricted and CAA-Core BAS are not interconnected.
5) No BAS wiring crosses the non-CAA, CAA-Restricted or CAA-Core boundaries.

b. Compatibility Certification: Submit manufacturer's certification that seats, gaskets and seals are compatible with design operating fluid(s).
c. Expandability Certification: Subcontractor must certify conformance with requirement for 25 percent future expansion panel space and conduit fill ratio space in accordance with the Part 1 Article on SUMMARY.

4. Graphic Pages: Submit sample graphics page for each type of page described in Part 2 Article on GRAPHICS PAGES.

C. Training Submittal (BASSUB-2) - Training Manuals for each Training Course:

1. Submit the following six weeks in advance of the scheduled training approved by site team and Project Director/COR:

a. List of training objectives.
b. Outline of the course with time allocations per topic.
c. Training presentation material (slides, word documents, etc.).
d. Copy of training reference material (product manuals to be used, etc.).
e. Description of measurement devices to measure training effectiveness (quizzes, programming exercises, course exam).

f. Instructor's name and resume, with emphasis on experience in presenting training programs.
g. Plan for specified video training documentation (e.g. site security approval for camera on site, who will take video, who will edit video onto DVD, Table of Contents of training to be recorded, and other requirements of Division 01 Section "Demonstration and Training"), and sample attendees sign-in sheet for record purposes.

2. Submit the following within three weeks after training has been completed:

a. List of attendees.
b. Performance scores on assessment devices.

D. Field Quality Control Submittal (BASSUB-3): Submit for review and approval test plans and reports associated with executing requirements described in Part 3 Articles on FIELD QUALITY CONTROL and ADJUSTING.

1. Submit the following testing plans at least four weeks prior to scheduled execution of testing:

a. DDC Verification Testing Plans
b. Operator Interface Verification Testing Plans
c. DDC Validation Testing Plans

2. Submit the following reports, documenting results of executed testing:

a. DDC Verification Testing Reports
b. Calibration Reports
c. Loop Tuning Reports
d. Operator Interface Verification Testing Reports
e. DDC Validation Testing Reports

3. Submit separate testing plans for each unique system tested.
4. Prepare and submit reports on a per system basis.
5. For each task in a testing plan, technician must enter their initials, date test was completed, and any recorded data (e.g., voltages, offsets, or tuning parameters). Each report must also record any deviations from submitted installation plan, issues encountered during testing and corrective measures taken.
6. Calibration reports must document measured value, reported value, and calculated offset for each sensor calibrated.
7. Loop tuning reports must document sample rate, gain and integral time constant for each control loop at completion of tuning.

E. Record Documentation Submittal (BASSUB-4): Record Documentation must include the Construction "As-Built" Manual, the Operation and Maintenance Manual and the Licenses in a single and complete package.

1. Construction "As-Built" Manual: Update of Construction Submittal, revised to reflect "As-Built" conditions. The following is a list of post construction submittals that must be updated to reflect any changes during construction and re-submitted as "As-Built".

    a. System architecture drawing including room numbers for the PC, printers, and each controller.
    b. Floor plans of each building and compound plan drawings showing BAS network routing (including conduit), pressure sensor tubing routing (including conduit), BAS panel locations, BAS network hardware locations, pressure sensor and sensing probe locations, HVAC equipment locations, room numbers, space sensor locations (temperature, CO2, occupancy, etc.), and controller addresses.
    c. Layout drawing for each control panel.
    d. Wiring diagram for each control panel.
    e. Wiring diagram for individual components.
    f. System flow diagram for each controlled system.
    g. Instrumentation list for each controlled system.
    h. Sequence of control for each system and piece of mechanical equipment.
    i. List of alarms and routing (PC, printer, Post 1, etc.).
    j. Building Pressurization System floor plans
    k. Soft copies of as-built programming must be posted on ProjNET, and also submitted on CDs. Refer to requirements of the Part 2 Article on DDC SOFTWARE AND FILES, and to Division 01 Section "Closeout Procedures."

2. Operation and Maintenance Manual: Operations and Maintenance Manual must consist of two parts and comply with Division 01 Section "Operation and Maintenance Data."

    a. Part I: Information common to the entire system. This must include, but not be limited to the following:

        1) Product manuals for key software tasks.

            a) Operating the system.
            b) Administering the system.
            c) Operator workstation.
            d) Application programming.
            e) Network servers and controllers.
            f) Setting up the web server.
            g) Report creation.
            h) Graphics creation.
            i) Re-installing graphics software and/or as-built programming from CD

        2) System architecture diagram.
        3) List of recommended maintenance tasks associated with system servers, operator workstations, data servers, web servers, and web clients.

            a) Define task.
            b) Recommend frequency for task.
            c) Reference product manual that includes instructions on executing task.

4) Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
5) Licenses for equipment and systems.
6) Submit three separate copies for PCC systems.

b. Part II: Information common to systems in single building.

1) System architecture diagram for components within building annotated with specific location information.
2) As-built drawing for each control panel.
3) As-built wiring design diagram for each control panel.
4) As-built wiring design diagram for all components.
5) Installation design details for each I/O device.
6) As-built system flow diagram for each system.
7) Sequence of control for each system.
8) Product data sheet for each component.
9) Installation data sheet for each component.

3. Licenses: Submit licenses from BAS manufacturer in accordance with the requirements in Part 1 Article on OWNERSHIP OF PROPRIETARY MATERIAL.

1.5 OWNERSHIP OF PROPRIETARY MATERIAL

A. Government retains all rights to software and passwords used for this project.

B. Government through the Project Director/COR will sign copy of manufacturer's standard software and firmware licensing agreement as condition of this contract. Such license must grant use of all programs and application software to Government as defined by manufacturer's license agreement but must protect manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. Licensing agreement must not preclude use of software by individuals under contract to Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to Government will be restricted to use on Government's computers, and only for purpose of commissioning, servicing, or altering installed system.

D. All hardware and software provided by Contractor for BAS must be U.S. licensed version, directly licensed to Department of State (DOS). The licensee of record must be, "The U.S. Department of State."

1. Licenses must allow post to work directly with BAS manufacturer. It must not be necessary after project warranty period for DOS to work through installing contractor to obtain parts, upgrades, and technical support from BAS manufacturer.

E. All project developed software, files and documentation must become property of Government. These include but are not limited to:

1. Server and Workstation software (including laptops)

2. Application Programming Tools
3. Configuration Tools
4. Addressing Tools
5. Application Files
6. Configuration Files
7. Graphic Files
8. Report Files
9. Graphic Symbol Libraries
10. All Documentation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Experienced installer who is authorized representative, certified installer, and/or approved installer of automatic control system manufacturer for both installation and maintenance of units required for this Project.

1. Controls Installer must possess and maintain Secret facility clearance with Secret safeguarding capability.

B. Manufacturer Qualifications: Firm experienced in manufacturing automatic temperature-control systems indicated for this Project and with a record of successful in-service performance.

1. BAS system must be manufactured in the U.S. or must have a U.S. version of hardware/software provided for the project.
2. BAS manufacturer must have U.S. training center that provides BAS operator, system programmer, and system installer training. This US based center must provide Government ready access to facilitate personnel attendance and to enable Government oversight of training.
3. BAS manufacturer must have U.S. parts supply base to accommodate shipment of components intended for use in restricted facility spaces.

C. Procurement Restrictions: Materials must not be procured or delivered to the job site more than six months prior to the intended date of installation.

D. Comply with requirements of the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

E. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

F. Design and install control systems and components in accordance with ASHRAE/ANSI Standard 135 (BACnet) protocol.

G. Controls Integration Meeting: Prior to beginning field installation, meet with Project Director/COR and project Commissioning Agent on approval of controls hardware, software,

strategies and procedures plan to develop a mutual understanding of details and system requirements. Ensure participation of BAS controls team members, equipment manufacturers' authorized service representatives with who BAS controls system will interface (e.g., fuel oil, fire alarm, TAB), and other support personnel. Provide 90 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include the following at minimum:

   a. Submittal distribution requirements.
   b. Contract Documents examination report.
   c. Control system calibration, point-to-point check, startup and commissioning plan.
   d. Work schedule and Project site access requirements.
   e. Coordination and cooperation of trades and subcontractors.
   f. Coordination of documentation and communication flow.
   g. Interface with third party software (e.g., water treatment skid, wastewater treatment skid, fuel oil system panel, chillers, boilers, kitchen hood, VFDs, ATSs).
   h. Review of first submittal package.
   i. Review of miscellaneous controls details and building pressurization.
   j. Confirm type of HVAC systems to be included in BAS mockup.

1.7 COORDINATION

A. General: Refer to “Related Sections” paragraph under the Part 1 Article on SUMMARY regarding systems requiring coordination with work of this Section.

B. Coordinate location of temperature, pressure and humidity sensors, and other exposed control components with plans and room details before installation.

C. Coordinate supply of electrical circuits, grounding and bonding for control units, printers, UPS, and operator workstation.

D. Coordinate equipment with Section 262417 “Panelboards” to achieve compatibility with starter coils and annunciation devices.

E. Coordinate equipment with Division 26 Section on motor-control centers to achieve compatibility with motor starters and annunciation devices.

F. Coordinate equipment with Division 26 Section on variable frequency motor controllers to achieve compatibility.

G. Coordinate equipment with Section 284626 "Addressable Fire Alarm Systems" to achieve compatibility with equipment that interfaces with that system.

H. Compound BAS Network: Coordinate BAS network hardware and installation with Division 27 subcontractor.

   1. BAS network must be designed by the 230905 subcontractor. This design must be provided to the Division 27 subcontractor for procurement and installation.

2. BAS network between buildings must utilize fiber optic cable.
3. BAS network fiber must be terminated on completely separate blocks from compound IT communication blocks (Telecommunications, Audio/Video, OpenNet, TSS, etc.) such that no interconnectivity can exist.
4. BAS network fiber must be terminated on completely separate blocks from other Building Management System (BMS) blocks such that no interconnectivity can exist. BMS include, but are not limited to, the Power Monitoring System, Lighting Control System, Photovoltaic Control System, Fire Alarm System, etc.
5. BAS network fiber, conduit and hardware (routers, switches, media converters, etc.) must be dedicated to the BAS and must not be shared with any other BMS.
6. Spare network fibers must be provided for all BAS network fiber runs. Spare fiber must be in the form of a separate and distinct cable.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, and that are packaged with protective covering for storage and identified with labels describing contents.

B. Replacement Materials: Provide 10 percent extra replacement sensors, relays, control transformers, actuators, VAV controllers, unitary plant controllers, network controllers, distributed I/O blocks/controllers, network interface modules, and routers of each type/model/sizes used on the project. If 10 percent is less than one, provide one. If 10 percent is greater than ten, provide ten.

1.9 MAINTENANCE SERVICE

A. Commencing at the contract’s Substantial Completion date for a period of one calendar year provide system maintenance service based on manufacturer's recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. In addition to the initial year of maintenance service, provide a proposal for a renewable option year. The option year proposal must be submitted 60 days prior to the end of the initial maintenance contract period.

B. Maintenance service must be inclusive of controls set-up and programming, troubleshooting, and alarms based on manufacturer's recommendations and the operation and maintenance information, using factory-trained service personnel.

C. Maintenance service must include preventive maintenance, repair or replacement of worn or defective components, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks must also align with the manufacturer's recommended checklists as required in Division 01 Section 017825 "Systems Manual and O&M Data." Provide completed maintenance records inclusive of scheduling to the USG for inclusion in the CMMS.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS, PRODUCTS, AND INSTALLERS

A. Products: Subject to compliance with requirements; manufacturers whose products may be incorporated into the Work, and the product lines permitted, are limited to the list below. Product lines used must be of the variant sold and installed within the continental United States.

1. Delta Controls – enteliWEB
2. Honeywell – Optimizer
3. Johnson Controls Incorporated – Metasys
4. Siemens – Desigo CC
5. Trane – Tracer SC+

B. Installers: Listed below are the BAS contractors that have been vetted by OBO and are permitted to install BAS by OBO. Only the BAS contractors listed below may be used.

1. Albireo Energy; Hoover, Alabama
2. Johnson Controls Federal Systems; Gaithersburg, Maryland
3. Siemens Government Systems; Reston, Virginia
4. Temperature Control Services; Lebanon, Indiana
5. Trane Building Automation Systems; St. Paul, Minnesota

C. Common BAS Product Line:

1. Office Buildings: The same manufacturer and BAS product line must be used in CAA areas as in GWA/PAA areas.
2. Compound: All buildings that require BAS must utilize only one common manufacturer and BAS product line.

a. For projects on an existing compound, new work must be provided with the same manufacturer and BAS product line as used in previously designed or constructed buildings.
b. For Posts with multiple compounds, the BAS product line used in new construction on any one of the compounds must be the same as the predominant BAS in use on any existing compounds, as determined by OBO.
c. If the existing product line is obsolete or outdated, an updated product line from the same manufacturer must be provided.

2.2 CONTROL SYSTEM

A. Provide DDC system with distributed processing. If network LAN is corrupted, all controllers must remain in operation using most recent data received over LAN.

B. Provide complete system of automatic temperature and pressurization control of HVAC system, including all control accessories and devices necessary to accomplish desired results, whether specifically mentioned herein or not.

C. Control system must be Direct Digital Control (DDC) system. DDC system must maintain stable temperature control and all other conditions as indicated. End-to-end accuracy of system, including temperature sensor error, wiring error, A/D conversion and display must be plus-or-minus 0.6 deg C (plus-or-minus 1 deg F).

D. DDC system must consist of Operator's Workstation (OW), multiple local area networks connecting components, Digital Controllers (DC) and Terminal Unit Controllers (TUC). All software control programs must reside in local controller for each item of equipment. All alarms must be sent to OW where they must be processed according to priority and job requirements.

E. Communications between DCs and OW, and between DCs and TUCs, must be through Local Area Networks (LAN). Design LAN for high speed communication; actual rate must not be less than 100 megabits for the LAN connecting DCs. LAN must allow sharing of data such as outside air temperature and alarm reporting. LAN must allow for uploading and downloading of software to or from DCs, from either OW or Portable Operator's Terminal (POT). LAN may be multi-level network. LAN must include error detection for transmission with correction and retransmission capability.

F. Prohibited Technologies: Controllers, computers, printers, sensors, network components, communication interfaces, diagnostic tools, configuration tools and other hardware that make up a BAS must be provided without the following capabilities:

1. Wireless Communications: The use or inclusion of any type of wireless communication technology is not permitted.

    a. Prohibited wireless communication technologies include, but are not limited to the following: Wi-Fi, Bluetooth and Near-Field Communications (NFC), Infrared (IR), Cellular (GSM, 3G, 4G, LTE, 5G…), ZigBee, Low Powered Wide Area Networks (LPWAN), Li-Fi, Z-Wave, Wireless USB, WiMax, Microwave, Radio (RF), Lightwave (Laser), etc.
    b. New wireless communication technologies, which do not currently exist at the time of the writing of this specification, are also prohibited.

2. Cameras: The use or inclusion of any type of image / video capture technology is not permitted. This includes any technology which would allow for images or video to be seen, recorded or transmitted by the hardware.
3. Microphones: The use or inclusion of any type of sound capture technology is not permitted. This includes any technology which would allow for sound to be heard, recorded or transmitted by the hardware.

G. Provide materials and installation labor necessary to connect to components factory supplied under other Sections, as part of equipment controlled.

H. Unless specified otherwise, provide fully modulating output devices operating valves and dampers.

I. Where "packaged equipment" is provided with its own integral controls, connect to packaged equipment with appropriate devices to effect operation described in Contract Documents. Do not

make connections/interconnections which result in packaged equipment manufacturer voiding their warranty. Intent of Construction Documents is to allow packaged equipment, once activated, to operate under their own controls unless specifically indicated otherwise herein. Contractor is responsible for coordinating with packaged equipment manufacturer as needed to ensure this operation.

J. Password Protection:

1. Provide multiple-level password access protection to limit workstation control, display and data base manipulation appropriate to each user. Create password to conform to the following complexity rules:

    a. Contain 12 or more characters.
    b. Contain mix of at least three characters from the following categories: Uppercase (A-Z), lowercase (a-z), numeric (0-9) and special (non-alphanumeric).
    c. Not be the same as user identifier.
    d. Not contain names or words.
    e. Not be generic (e.g., admin or system passwords).

2. Each user must be prompted to change password at least once every 60 days or at next login attempt thereafter.
3. For all password-protected components, passwords on network must be propagated and updated from OW. Users must not be required to update passwords at each Digital Control Unit.
4. Minimum five levels of access must be supported:

    a. Level 1 = Data Access and Display
    b. Level 2 = Level 1 + Selected Operator Overrides
    c. Level 3 = Level 2 + Set point Adjust
    d. Level 4 = Level 3 +Database Modification
    e. Level 5 = Level 4 + Security and Password Additions/Modifications

5. All setpoints must be adjustable at OW by easily accessible on-screen dialog box, slider, or other approved man-machine interface.
6. Password Retention: For each OW and Server at Post, Contractor must set up the following:

    a. Administrator Account: Create Administrator-level user account labeled “OBO Sys Admin” in Operating System, BAS Software, and all other associated software (e.g., Encryption software). This account must be configured in such a manner that it cannot be deleted by another user account. Contractor must utilize random password generator to create initial password for this account. This password must be submitted to Project Director/COR or OBO/PDCS/DE project team Mechanical Engineer.
    b. Password Management: Create tables listing Operating System user accounts, BAS user accounts and all other associated software user accounts that exist within each OW and Server. Each table must identify associated OW and Server, Operating System User Account / BAS User Account / Encryption Software / etc., including the following information:

1) User Account Name.
2) Name of person associated with the User Account.
3) Type of user account (Administrator, Standard User, etc.).
4) Account permissions associated with User Account (if applicable).

c. The Contractor must not collect password information for individual user accounts.

7. All manufacturer default usernames and passwords must be removed, and new usernames and passwords must be created for all BAS devices using random password generator. These usernames and passwords must be submitted to Project Director/COR or to OBO/PDCS/DE Project team Mechanical Engineer.

K. Floating point control is acceptable for use at room level for VAV terminals, fan coil units, and similar equipment. All other analog devices must be true analog using 0-10 VDC or 4-20 MA signals.

L. Control system must interface with the following systems identified in "Related Sections":

1. Medical Equipment such as **[Laboratory Fume Hood and]** pharmaceutical refrigerator temperature alarm.
2. Potable Water Treatment, Water Booster Pumps, and Water Softeners.
3. Wastewater Treatment.
4. Computer Room Air Conditioning Unit and Water Leak Detection Systems.
5. Chillers, boilers, AHUs, VAVs and similar HVAC equipment.
6. Building Power Monitoring System.
7. Variable Frequency Drives.
8. Centralized Dimming Control System.
9. Engine Generators.
10. Fuel Monitoring and Management System.
11. Solar Photovoltaic and Solar Hot Water Systems.
12. Variable Refrigerant Volume/Flow (VRV/VRF) Systems using manufacturer's recommended Building Controller.

2.3 DDC SOFTWARE AND FILES

A. Software:

1. Submit copy of all software installed on servers, workstations, and laptops.
2. Submit copy of all software used to execute the project, even if software was not installed on servers, workstations, and laptops.
3. All software revisions must be as installed at time of system acceptance.

B. Firmware Files:

1. Submit copy of all firmware files downloaded to, or pre-installed on, any devices installed as part of this project.
2. This does not apply to firmware permanently burned on chip at factory which can only be replaced by replacing chip.

3. Submit copy of all application files created during execution of the project.
4. Submit copy of all graphic page files created during execution of the project.

C. Secondary Graphics Files: Submit copy of all secondary graphic files (e.g., bitmaps, jpegs) used in creation of graphic pages.

D. Application Software:

1. I/O capability from operator station.
2. System security for each operator via software password and access levels.
3. Automatic system diagnostics; monitor system and report failures.
4. Database creation and support.
5. Automatic and manual database save and restore.
6. Dynamic color graphic displays for risers, floor plans, and other system level displays.
7. Custom graphics generation and graphics library of HVAC equipment and symbols.
8. Alarm processing, messages, and reactions.
9. Trend logs retrievable in spreadsheets and database programs.
10. Alarm and event processing.
11. Object and property status and control.
12. Automatic restart of field equipment on restoration of power.
13. Data collection, reports, and logs. Include standard reports for the following:

    a. Current alarm summary.
    b. Disabled objects.
    c. Alarm lockout objects.
    d. Logs.
    e. Energy usage/operation times

14. Custom report development.
15. Utility reports.
16. Workstation application editors for controllers and schedules.
17. Maintenance management.

E. Custom Application Software:

1. English language only.
2. Full-screen character editor/programming environment.
3. Allow development of independently executing program modules with debugging/simulation capability.
4. Support conditional statements.
5. Support floating-point arithmetic with mathematic functions.
6. Contains predefined time variables.

2.4 DDC EQUIPMENT

A. Operator Workstation: Desktop computer(s) with minimum configuration as follows:

1. Motherboard: With minimum of four integrated USB 3.2 Type-A ports and 1 Type-C port; integrated 10/100/1000 Ethernet port with RJ45 connection; integrated audio, bios, and hardware monitoring; and two integrated HDMI ports.
2. Processor: Minimum 8 Core, 3.2 GHz w/10MB Cache; AMD RYZEN 3rd Gen/Intel CORE 10th Gen or newer
3. Random-Access Memory: Minimum of 32.0 GB.
4. Graphics Processor: AMD Radeon Pro WX 3200, NVIDIA Quadro P1000 or equivalent expansion card with minimum of 4 GB dedicated video memory.
5. Storage Media: Two enterprise-grade SATA hard drives in a RAID 1 (mirrored) configuration, minimum size of 1 TB each, minimum rotational speed of 7200 RPM. RAID must be configured and managed through software using the built-in Windows Operating System Disk Management utility. The drives must be hot-swappable to allow for removal and replacement while the system is still operational.
6. Removable Media: CD/DVD Read/Write Drive.
7. Keyboard: U.S. English; QWERTY, 105 keys; wired.
8. Mouse: Optical three-button mouse with scroll wheel, wired.
9. Displays: Two 686 mm (27 inch) LED monitors, resolution: 4K (3840x2160p@60Hz); Aspect Ratio: 16:9; Brightness: Minimum of 300 nt.
10. Printer: Color, laser type as follows:

    a. Printer Resolution: Minimum of 1200 x 1200 dpi -optimized color resolution.
    b. Paper Handling: Minimum of 100 sheets, duplex capable.
    c. Print Speed: Minimum of 24 ppm in black and 24 ppm in color.
    d. Print Size: 8-1/2” by 11”, A4, and 11” by 17”.
    e. Provide USB and 10/100 Ethernet ports for connectivity.

11. Operating System: Microsoft Windows Professional, most current version that is compatible with installed BAS software.
12. Productivity Software: Microsoft Office Suite (including Word and Excel); Adobe Acrobat Professional; and AutoCAD LT.
13. Security Software: Department approved encryption and antivirus software.
14. BAS Application Software: As required to interface with digital controllers over the BAS network or through direct communication interface.
15. BAS Graphical User Interface: Complete graphics software package, including utilities required to modify and create graphics.
16. Stand Alone Functionality: Software provided must not require internet connectivity or subscriptions to function.
17. Extended Warranty: Operator Workstations and the software installed on them, as described above, must be warranted for a period of 5 years from the date of turnover to the Government.

B. Portable Operator Workstation: Provide three portable, notebook-style computers, one for the unclassified BAS, one for CAA BAS use only, and one for PCC use only. Each computer must be capable of accessing system data by connecting to the associated system’s network. Provide computers with minimum configuration as follows:

1. Durability: Rugged or semi-rugged. Meet or exceed MIL-STD-810H and IP53 rating.

2. Base Hardware: Minimum of two integrated USB 3.2 Type-A ports and one Type-C port; integrated 10/100/1000 Ethernet port with RJ45 connector; integrated audio, bios, and hardware monitoring; and 1 integrated HDMI port.
3. Processor: Minimum 4 Core, 1.8 GHz w/8MB Cache; AMD RYZEN 3rd Gen/Intel CORE 10th Gen or newer.
4. Random-Access Memory: Minimum of 16.0 GB.
5. Graphic Processor: Integrated, shared memory.
6. Display: 430 mm (17 inches) LED anti-reflective screen; Resolution: 1920x1080p at 60Hz; Aspect Ratio: 16:9; Brightness: Minimum of 300 nt.
7. Storage Media: Two enterprise-grade M.2 NVMe solid state drives in RAID 1 (mirrored) configuration, minimum size of 1 TB each. RAID must be configured and managed through software using the built-in Windows Operating System Disk Management utility.
8. Removable Battery: Battery must be removable and capable of being replaced without the need to open or otherwise disassemble the computer.
9. Removable Media: CD/DVD Read/Write Drive.
10. Mouse: Touch pad or other internal device, and separate optical three-button mouse with scroll wheel, wired.
11. Operating System: Microsoft Windows Professional, most current version that is compatible with the installed BAS software.
12. Productivity Software: Microsoft Office Suite (including Word and Excel); Adobe Acrobat Professional; and AutoCAD LT.
13. Security Software: Department approved encryption and antivirus software.
14. BAS Application Software: As required to interface with digital controllers over the BAS network or through direct communication interface.
15. BAS Graphical User Interface: Complete graphics software package, including utilities required to modify and create graphics.
16. Stand Alone Functionality: Software provided must not require internet connectivity or subscriptions to function.
17. Extended Warranty: Portable Operator Workstations and the software installed on them, as described above, must be warranted for a period of 5 years from the date of turnover to the Government.

C. Critical Alarm Panel. Provide HMI panel for monitoring of critical alarms from BAS. Locate at Post 1 when Post 1 is continually occupied. Locate at CAC (guarded 24/7) for Lock and Leave Posts. Provide Siemens MTP1500 HMI or equivalent. Mount onto unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 1.5-mm (0.06-inch) thick, furniture-quality steel or extruded-aluminum alloy, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

1. Alarm Condition: Red color indication flashes on alarm message and buzzer sounds.
2. Acknowledged Alarm: Buzzer must be silent, and yellow color indication steady.
3. Second Alarm: Buzzer must sound, and red color indication steady.
4. Alarm Condition Cleared: System must be reset, and color indication extinguished.
5. Contacts in alarm panel must allow remote monitoring.

D. Digital Control Units: Modular, self-contained, stand-alone controller comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and memory backup to maintain program for at least 48

hours. Backup power source is required if controller has no other means of memory backup. Provide digital controller at each air handling unit, each heating system and each cooling system as minimum.

1. Units perform the following: Monitor or control each I/O point; process information; execute commands from other control units, devices, and operator workstations; and download from or upload to operator workstations. Operation of operator workstation must only be necessary to reset digital controllers clock, and to send alarm messages or data to operator at operators workstation.
2. Units must be Ethernet capable at I/O level without need for any additional routers or gateways.
3. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Software applications, scheduling, and alarm processing.
    e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

4. Standard Application Programs:

    a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, PID control, DDC with fine tuning, and trend logging.
    b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
    d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    e. Provide tabular display of terminal unit information for each terminal unit.
    f. Units of Measure: Inch-pound and SI (metric).
    g. Identify all valve output signals as percent open to heat transfer coil
    h. Identify all damper actuator output signals as percent open

5. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

E. Local Control Units: Application specific, modular controller, comprising processor board with electronically programmable, nonvolatile, read-only memory; and memory backup to maintain program for at least 48 hours. Backup power source is required if controller has no other means of memory backup.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Self-diagnostics of internal components.
    e. Proportional and proportional plus integral control loops.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. Reside on second level LAN, with at least one communication port.
5. Provide capability to have separate heating and cooling setpoints as much as 4.5 deg C apart with “no energy band” between two setpoints.
6. Provide transformer of sufficient capacity to power controller and actuators controlled by terminal unit controller. Provide manual primary side disconnect switch meeting NEC requirements.

F. Unitary Controllers: Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for application.

1. Configuration: Local display with keypad or touch screen at each equipment control panel with unitary controllers; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with BIOS; and memory backup to maintain program for at least 72 hours. Backup power source is required if controller has no other means of memory backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. Compliance with ASHRAE 135 is required.
4. Enclosure (Indoor): Dustproof-rated for operation at 0 to 50 deg C (32 to 120 deg F). Rated for plenum use where installed in plenum (i.e., VAV terminal boxes).
5. Enclosure (Outdoor): NEMA 4 rated for operation at 5 to 65 deg C (40 to 150 deg F).
6. At minimum, one panel within each mechanical equipment room must contain one RJ45 jack for network communications and GUI graphics via laptop for troubleshooting.

G. I/O Interface: Hardwired inputs and outputs must tie into system through digital controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Floating Point or Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

2.5 GRAPHICS PAGES

A. Hierarchy:

1. The organization of graphic pages must be from global level down to very detailed level through series of links.
2. Linking must allow operator to move down hierarchy, up hierarchy and laterally within hierarchy.

B. Hierarchy Outline:

1. Site Plan Page: Visual representation of site (map). One page or multiple linked pages, depending on size of site plan.

    a. Link to individual building graphic pages.
    b. Link to Utility Management page.
    c. Display outdoor weather conditions.

2. Utility Management Page: Summary of data on utility consumption for site.

    a. Link up to site plan.
    b. Display:

        1) Utility consumption data (electricity, gas, fuel oil, water).
        2) Power Monitoring data, including:

            a) Demand
            b) Voltages, currents, and power factors.
            c) Demand control actions currently in effect.

    c. Presentation of utility management data may require more than one graphic page to effectively report data from multiple meters.

3. Building Graphic Page: Typically picture of building. One page per building.

    a. Link to floor plans within building.
    b. Link to central plant graphics where plant serves entire building.
    c. Link to delivery systems if delivery system serves entire building

d. Link up to site plan.

4. Building Pressurization Page: Schematic of building showing each pressure zone and displaying all pressure values.

   a. Link up to Building Page
   b. Link to floor plans within building.
   c. Link to Delivery System page (AHU) for each floor or pressurization area.

5. Floor Plan Page: This will be a two-dimensional plan of floor area. Minimum of one page per floor, per building is required. Where floor plans are large, multiple linked pages are required. For each control zone, display values of monitored and controlled parameters. This will typically include occupancy sensors, carbon dioxide levels, temperatures, and relative humidity levels.

   a. Link up to Building page.
   b. Link up to Site Plan page.
   c. Link to any delivery system that serves floor plan area (air handling unit is typical).
   d. Link to time schedules that affect systems that serve area.
   e. Link to Terminal Unit Summary page such as VAVs or fan coil units.
   f. Identify individual control zones.
   g. Show location of terminal equipment serving each zone.
   h. Show location of sensors installed in occupied space.
   i. Show room numbers, where available.

6. Central Plant Page: Graphical representation of equipment that makes up plant (e.g., chillers, pumps, boilers). If plant is small, this graphic must display values of process variables and commands to end devices. If plant is complex this graphic must only contain links to equipment graphics. Provide page for each plant.

   a. Link up to Building page.
   b. Link up to Site Plan page.
   c. Link to Central Plant Equipment Component page (e.g., chiller, pumps, tower).
   d. Graphic representation of the equipment must be 3-dimensional.
   e. Display:

      1) Process variables.
      2) Commands to end devices.
      3) Status of end devices.
      4) Alarm points if this is only central plant graphic.
      5) Plant status (enabled/disabled).
      6) Demand control status.

   f. Link to any time schedules that affect operation of plant.
   g. Link to any pre-configured trend charts associated with performance of plant.
   h. Link to Central Plant Configuration Page.

7. Central Plant Equipment Component: Graphical representation of element of equipment (e.g., chiller, pumps, boiler, tower, or some combination of these). Provide page for each primary equipment item per plant.

    a. Link up to Central Plant page.
    b. Link up to Building page.
    c. Link up to Site Plan page.
    d. Graphic representation of the equipment must be 3-dimensional.
    e. Display:

        1) Process variables.
        2) Commands to end devices.
        3) Status of end devices.
        4) Alarm points.
        5) Equipment status (enabled/disabled).
        6) Demand control status.

    f. Link to any time schedules that affect operation of equipment component.
    g. Link to any pre-configured trend charts associated with performance of equipment component.
    h. Link to Central Plant Configuration Page.

8. Central Plant Configuration Page: On this page, operator is given access to configuration parameters for entire plant or for piece of equipment in plant. Typically, this page presents data in tabular format. Type of data on this page is not changed frequently, but operator may wish to view it frequently. Provide one page per plant for small plants, and one page per primary equipment item per plant for larger plants.

    a. Set Points.
    b. Tuning Parameters.
    c. Calibration Parameters.
    d. Timing Parameters.
    e. Application parameters.
    f. Reset Schedules.
    g. Lead Lag Information.
    h. Time Schedules.
    i. Link up to Equipment or Central Plant page.
    j. Link up to Building page.

9. Delivery System Page: Graphical representation of air or water delivery system (e.g., air handling unit, roof top air handling unit, computer room air conditioning unit). One page for each delivery system.

    a. If Delivery System serves specific floor area, link up to Floor Area page.
    b. Link up to Building page.
    c. Link up to Site Plan page.
    d. Link to Central Plant page if Delivery System is served by Central Plant.

e. If Delivery System supplies multiple terminal devices, link to Terminal Unit Summary page.
f. Link to Delivery System Configuration page.
g. Graphical representation of equipment must be 3-dimensional and represent true physical characteristics of installed system.
h. Display:

1) Process variables.
2) Commands to end devices.
3) Status of end devices.
4) Status of different modes (economizer on/off, mechanical cooling enabled/disabled, occupied/unoccupied).
5) Alarm points.

i. Link to any time schedules that affect system operation.
j. Link to any pre-configured trend charts for system.

10. Delivery System Configuration Page: On this page, operator is given access to configuration parameters for delivery system. Typically, this page presents data in tabular format. Type of data on this page is not changed frequently, but operator may wish to view it frequently. One page per delivery system is required.

a. Display:

1) Set Points.
2) Tuning Parameters.
3) Calibration Parameters.
4) Timing Parameters.
5) Application parameters.
6) Reset Schedules.
7) Lead Lag Information
8) Time Schedules.

b. Link up to Delivery System page.
c. Link up to Building page.
d. Link up to Site Plan page.

11. Terminal Unit Summary Page: On this page, dynamic data and set points associated with multiple terminal units are presented in tabular format. Objective is to present summary of terminal unit performance for an area of facility. Provide one page for each group of terminal units. In tabular data, do not use less than 12 pt font size. Multiple linked pages may be used if there are large number of terminals served by one delivery system.

a. Display the following in table:

1) Process variables.
2) Set points for each process.
3) Command to each end device.

4) Status of each end device.
5) Load factors such as terminal load for VAV terminal unit.

b. Link to page for each Terminal Unit.
c. Link up to Delivery System page.
d. Link up to Floor Plan page.
e. Link up to Building page.
f. Link up to Site Plan page.

12. Terminal Unit Page: Graphical representation of terminal unit such as VAV terminal or fan coil terminal. Provide one page for each terminal unit.

a. Link up to Terminal Summary page.
b. Link up to Floor Plan page.
c. Link up to Building page.
d. Link up to Site Plan page.
e. Graphic representation of equipment must be 3-dimensional, and must represent actual installed terminal unit (e.g., if VAV does not have fan, then fan should not be shown).
f. Display

1) Process variables.
2) Command to end devices.
3) Status of end devices.
4) Set points for each process.
5) Modes (e.g., auto, heat, cool).
6) Capacity indicators (e.g., terminal load, percent heat, percent cool).
7) Reset schedules.
8) Occupancy commands and status.
9) Alarm points.

C. For all points on graphic page that are subject to being under manual or test mode, display must indicate when test mode or manual mode has been applied to point.

D. Graphic Page Requirements:

1. Sequence of operation must define buildings, as well as all equipment items for which graphic pages are developed as described above.
2. Develop similar additional graphic pages, to be defined during construction period, as follows:

a. Up to five additional pages per building.
b. Up to twenty additional global pages.

2.6 TRANSFORMERS AND POWER SUPPLIES

A. AC Transformers:

1. Listing: UL Class 2 (current-limiting).
2. Power Rating / Transformer Size: Maximum of 100 VA.
3. Primary Protection: Provide a DIN mounted circuit breaker next to the transformer to protect against overcurrent, overload, and short circuits and to act as a means of disconnect for the transformer.
4. Secondary Protection: Circuit breaker.
5. Restrictions:

    a. Limit connected loads to 80 percent of rated capacity.
    b. Transformers with more than one secondary output are not permitted.

B. Linear DC Power Supplies:

1. Output Ripple: Maximum of 5.0 mV peak-to-peak.
2. Line Regulation: Less than 0.1 percent for a 10 percent line change.
3. Load Regulation: Less than 0.1 percent for a 50 percent load change.
4. Transient Response Time: Less than 100 milliseconds for a 50 percent load change.
5. Primary Protection: Provide a DIN mounted circuit breaker next to the power supply to protect against overcurrent, overload, and short circuits and to act as a means of disconnect for the power supply.
6. Secondary Protection: Provide secondary output with overload and overvoltage protection. Use add-on module if required by product for overvoltage protection.
7. Restrictions:

    a. Limit connected loads to 80 percent of rated capacity.
    b. Power supplies with more than one secondary output are not permitted.

C. Switching (PWM) DC Power Supplies:

1. Output Ripple: Maximum of 50.0 mV peak-to-peak.
2. Line Regulation: Less than 1 percent.
3. Load Regulation: Less than 1 percent.
4. Primary Protection: Provide a DIN mounted circuit breaker next to the power supply to protect against overcurrent, overload and short circuits and to act as a means of disconnect for the power supply.
5. Secondary Protection: Provide secondary output with overload and overvoltage protection.
6. Mounting: DIN Rail.
7. Restrictions:

    a. Limit connected loads to 80 percent of rated capacity.
    b. Power supplies with more than one secondary output are not permitted.

D. Uninterruptable Power Supplies (UPS):

1. Voltage Regulation: On-line, Double Conversion power conditioning.
2. Output Waveform: Pure Sine Wave.
3. Line to Battery Transfer Time: 0 ms.
4. Batteries: User replaceable, hot swappable, maintenance free.

5. Surge & Noise Suppression: Provide with EMI / RFI noise suppression and surge suppression. Surge suppression rating shall be a minimum of 150 Joules.
6. Fault Tolerance: Provide with automatic bypass to maintain utility output during a fault or overload condition.
7. Display / Interface: Include front panel with power switch and visual indication of power, battery, fault and temperature. Unit shall include an audible alarm of faults and front panel silence feature. UPS settings must be adjustable through the front panel.
8. Alarm Contact: Provide with a dry contact for monitoring by BAS of general alarm, including battery failure.
9. Communications: Provide with communication port for monitoring by Operator Workstations and Servers. Configure to provide an orderly shutdown of Operator Workstation / Server if power has not been restored and battery power falls below 20 percent.
10. Installation: UPS must be installed above the floor in a panel or on a raised surface to protect from foot traffic and damage.
11. Sizing: Size UPS for 15 minutes of operation of all connected loads. Calculations must be provided for each UPS to show requirement has been met.
12. The following BAS related equipment must be provided with uninterruptible power supplies:

    a. Operator Workstation and associated equipment, including printers.
    b. Servers.
    c. DDC Control Panels (excluding terminal unit controllers such as VAV controllers).
    d. Gateways.
    e. Networking Equipment.

2.7 ELECTRONIC SENSORS

A. Description: Provide wall, immersion, or duct mounting as required. Sensors must be vibration and corrosion resistant.

B. Temperature Sensors:

1. Thermistor Accuracy: Plus-or-minus 0.2 deg C (0.35 deg F) at calibration point.
2. Temperature sensors must be thermistors, and meet performance requirements
3. Duct Temperature Sensor: Operating Range: 5 to 60 deg C (40 to 140 deg F). Conformity: Plus-or-minus 1 deg C (2 deg F). Single point, 200 mm (8 inches) long; use where not affected by temperature stratification or where ducts are smaller than 0.85 sq. m (9 sq. ft.).
4. Averaging Elements in Ducts: 900 mm (36 inches) long, flexible; use where prone to temperature stratification or where ducts are larger than 0.85 sq. m (9 sq. ft.); length as required.
5. Chilled Water Temperature Sensors: Operating Range: -1 to +40 deg C (30 to 100 deg F). Conformity: Plus-or-minus 0.5 deg C (1 deg F).
6. Heating Hot Water: Operating Range: 20 to 120 deg C (70 to 250 deg F). Conformity: Plus-or-minus 1 deg C (2 deg F).

7. Insertion Elements for Liquids: Thermowells must be series 300 threaded stainless steel. Inside diameter and insertion length must be as required for the application. Fill thermowells with manufacturer recommended thermal-conducting material.
8. Outside-Air Sensors: Operating Range: -45 to +65 deg C (-50 to +150 deg F). Conformity: Plus-or-minus 1 deg C (2 deg F). Watertight inlet fitting, shielded from direct sunlight.
9. Room Sensors: Operating Range: 10 to 30 deg C (50 to 86 deg F). Conformity: Plus-or-minus 0.5 deg C (1 deg F) over specified operating range. Equip with set point adjustment, override switch and communication port.
10. Room Security Sensors (Use in Public Access Areas): Stainless-steel cover plate with insulated back and security screws.
11. Unconditioned Space Temperature Sensors: Operating Range: -7 to +65 deg C (20 to 150 deg F). Conformity: Plus-or-minus 0.5 deg C (1 deg F) between 10 to 30 deg C (50 and 86 deg F), and plus-or-minus 1 deg C (2 deg F) over remaining range.
12. Point Temperature Sensors: Series 300 stainless steel, anodized aluminum, or copper. Encapsulate in epoxy.
13. Hydronic Load Monitoring (Thermal Energy Metering): Provide matched pair temperature sensors, matched to +/- 0.05 deg C (+/- 0.1 deg F) with calibration certificate.

C. Humidity Sensors:

1. Use bulk polymer, resistive, or thin film capacitive type, with non-saturating sensing elements capable of withstanding saturated condition without permanently affecting calibration or sustaining damage.
2. Conformity: +/- 2 percent relative humidity.
3. Environmental Range: -5 to +60 deg C (25 to 140 deg F).
4. Long Term Stability: Less than 1 percent drift per year.
5. Sensors must be wall-mounted or duct-mounted type as required by application. Provide accessories for complete and functional installation.

    a. Room Sensors: With locking cover matching room temperature sensors, range of 10 to 90 percent relative humidity. For indoor installations, sensor calibration must not be altered by exposure to condensing airstream.
    b. Outside Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity. For exterior installations, sensors must survive below-freezing temperatures and direct contact with moisture without affecting sensor calibration.
    c. Duct Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity. Sensors used in duct high limit applications must use bulk polymer resistive sensing element. Equip duct-mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage. Support sensors inside ducts as recommended by manufacturer based upon design air speed range.

6. Signal output: Match needs of BAS system (0-10V, 4-20mA).

D. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

    a. Accuracy: +/- 0.25 percent of full scale with repeatability of 0.5 percent or less.
    b. Output: 4 to 20 mA.
    c. Building Static Pressure Range: +/- 25 Pa (+/-0.1-inch wg).
    d. Duct Static-Pressure Range: 0 to 1240 Pa (0- to 5-inch wg).

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 1034-kPa (150-psig) operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 1034-kPa (150-psig) operating pressure and tested to 2070-kPa (300-psig); linear output 4 to 20 mA. Transmitter must include five-valve manifold.
4. Differential-Pressure Switch (Air or Water): SPDT Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Zone Differential-Air-Pressure Control and Monitoring:

    a. Monitor must measure bi-directional pressure differential between two spaces and send analog pressure differential signal to Building Automation System.
    b. System must consist of differential pressure sensors, pneumatic tubing and low pressure and high pressure sensing probes.
    c. Pressure range must be between minus 50 Pa (minus 0.2-inch wg) and plus 50 Pa (plus 0.2-inch wg), and user configurable to range of minus 25 Pa (minus 0.10-inch wg) and plus 25 Pa (plus 0.10-inch wg).
    d. Accuracy of measurement must be within plus/minus 0.5 percent full scale.
    e. Analog output of room pressure differential must be either 0-10V or 4-20 mA.
    f. Transducer must have a minimum of 10kPa positive and negative overpressure protection.
    g. Outdoor Static Pressure Probe.

        1) Stainless steel sensor probe with no moving parts.
        2) Operation not affected and impaired by rain and snow.
        3) The outdoor air probe shall be capable of sensing the outside atmospheric air pressure to within 2 percent of the actual value when subjected to radial wind velocities up to 40 miles per hour with approach angles up to 30 degrees to the horizontal.
        4) Installed in accordance with manufacturers recommendations.
        5) Designed specifically for outdoor applications.

6. Control and Instrumentation Tubing:

    a. Type ACR, copper tubing complying with ASTM B 280.

        1) Fittings: Cast-bronze solder fittings complying with ASME B16.18, or wrought-copper solder fittings complying with ASME B16.22, except forged-brass compression type fittings at connections to equipment
        2) Joining Method: Soldered or brazed.

3) Install copper tubing segments (approximately 1 meter long) where plastic tubing control systems penetrate fire rated floors and partitions

b. Virgin-polyethylene, flame-retardant, nonmetallic tubing complying with ASTM D638.

1) Fittings: Compression or push-on polyethylene fittings.

2.8 STATUS SENSORS

A. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

B. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

C. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

D. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

E. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc or 4-20 mA, feedback signal.

F. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

G. Electric Low Limit Duct Thermostat (Freezestat): Snap acting, double pole, double throw, manual reset switch that trips if temperature sensed across any 1 foot of bulb length is equal to or below setpoint.

1. Bulb Length: Minimum of 6 meters (20 feet).
2. Quantity: One thermostat for every 2 sq. meters (20 sq. ft.) of coil surface.

H. Passive Infrared Occupancy Sensors: PIR occupancy sensors must have multi-level, multi-segmented viewing lens and conical field of view, with viewing angle of 180 degrees and detection of at least 6 meters (20 feet) unless otherwise shown or specified. PIR Sensors must provide field-adjustable background light-level adjustment, with adjustment range suitable to light level in sensed area, room, or space. PIR sensors must be immune to false triggering from RFI and EMI.

2.9 GAS DETECTION EQUIPMENT

A. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with 3-year minimum life; suitable over temperature range of 0 to 40 deg C (32 to 104 deg F); with 2 factory-calibrated alarm levels at 50 and 100 ppm or adjustable levels.

B. Carbon Dioxide Sensor and Transmitter: Single detector using solid-state infrared sensor; operating temperature range of 0 to 50 deg C (32 to 122 deg F); measurement range of 0 to 2000 ppm; accuracy, 2% of reading +/-30 ppm; repeatability, 1% of full scale; output, 4 to 20 mA or 0-10 Vdc; for wall mounting or duct installation. Provide appropriate mounting hardware for application in accordance with manufacturer's installation instructions.

C. Provide hydrogen detection system for each battery room as required to comply with the OBO Electrical Code. Each system consisting of one central control panel linked with up to three remote hydrogen sensors. Provide wall-mount system with NEMA 4X rating enclosure; system must be suitable for non-hazardous service. Basis of Design for control panel: Mine Safety Appliances Co. (MSA), Model Ultima XA, Combustible Gas Detection System. Provide panel with LCD display, manual warning and alarm reset, power failure alarm, and inhibit relays. Electrical characteristics must be 115V-1 with full circuit protection. Alarm unit must be able to activate exhaust fan as indicated in sequences of operation. Provide hydrogen sensors throughout Battery Room in accordance with manufacturer's recommendations for optimum coverage. Basis of Design for sensors: MSA Co. Ultima XA series. Locate audible alarm horn outside Battery Room. Include provision for remote alarm in each panel. Provide all wiring and conduit for sensors, panels, and alarms associated with this Section. Provide sensor calibration and test kit to calibrate at normal levels and confirm alarming at concentrations just above alarm point.

D. If included in the project, reference Division 23 Section on refrigerant monitoring and safety equipment.

2.10 FLOW MEASURING

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Casing: Galvanized-steel frame.
2. Accuracy: Plus-or-minus 2 percent to 6000 fpm.
3. Flow Straightener: Aluminum honeycomb, 20-mm (3/4-inch) parallel cell, 75 mm (3 inches) deep.
4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

B. Water Flow Sensor: Water flow element/transmitter assemblies must be insertion type.

1. Accuracy: Plus-or-minus 0.5 percent at calibrated flow velocity. Provide meter with NIST factory calibration.
2. Output: Linear, two wire 4 to 20 mA or 0 to 10 V signal corresponding to the flow rate.
3. Enclosure: NEMA 4.
4. For pipe diameters DN65 (2-1/2 inches) and larger, provide dual turbine flow meter. Single turbine flow meters are acceptable for pipe sizes smaller than DN 65.

5. Locate flow meter according to manufacturer's guidelines with respect to straight pipe length. Ensure sufficient clearance around pipe for sensor.
6. Install Flow Sensor with shut-off/isolation full port ball valve to allow for adding/removing sensor while water system is in use.
7. Install Flow Meters in upper half of horizontal run pipes or in vertical pipe runs. Install meters perpendicular to pipe.

2.11 THERMOSTATS

A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Capability of reporting to BAS.
10. Thermostat display features include the following:

    a. Time of day.
    b. Actual room temperature.
    c. Programmed temperature.
    d. Programmed time.
    e. Duration of timed override.
    f. Day of week.
    g. System mode indications include "heating," "off," "fan auto," and "fan on."

2.12 HUMIDISTATS

A. Duct-Mounted Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.13 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action. Select actuators for 150 percent of required torque. Torque provided must be as close to 150 percent as possible without falling below 150 percent.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear-trains type; Equip spring-return motors with integral spring mechanism in housing designed for easy access or adjustment of limit switches.

2. Non-spring-Return Motors for Valves Larger than DN 65: Size for running torque of 17 N x m and breakaway torque of 35 N x m.
3. Non-spring-Return Motors for Dampers Larger than 2.3 sq. m: Size for running torque of 17 N x m and breakaway torque of 35 N x m.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque. Select actuator rating for 150 percent of required torque. Torque provided must be as close to 150 percent as possible without falling below 150 percent.

1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:

a. Opposed-Blade Damper with Edge Seals: 62 kg-cm/sq. m of damper.
b. Opposed-Blade Damper without Edge Seals: 37.2 kg-cm/sq. m of damper.
c. Dampers with 500 to 750 Pa of Pressure Drop or Face Velocities of 5 to 13 m/s: Multiply minimum break away torque above by 1.5.
d. Dampers with 750 to 1000 Pa of Pressure Drop or Face Velocities of 13 to 15 m/s: Multiply minimum break away torque above by 2.0.

3. Coupling: V-bolt and V-shaped, toothed cradle. Single set screw is not sufficient.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical Spring Return mechanism. Provide external, manual gear release on non-spring-return actuators.
6. Power Requirements (Two-position Spring Return): 24VAC
7. Power Requirements (Modulating): Maximum 10 VA at 24-VAC or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: Minus 30 to plus 50 deg C.
10. Temperature Rating (Smoke Dampers): -30 to +121 deg C.
11. Equip all actuators for Two-Position operation with end switches unless otherwise noted.
12. Manual Override: External manual adjustment mechanism to facilitate manual positioning when actuator is not powered.

2.14 CONTROL VALVES

A. General:

1. Valves must have stainless-steel stems and stuffing boxes with extended necks to clear piping insulation. Valve bodies must conform to ANSI/ASME B16.34 or ANSI/ASME B16.15 pressure and temperature class ratings, based upon design operating temperature and 150 percent of system design operating pressure.
2. Unless otherwise specified or shown, valve leakage must conform to ANSI/FCI 70-2 Class IV leakage rating (0.01 percent of valve Kv).
3. Unless otherwise specified or shown, valves DN50 (2 inches) or smaller must be ball valves; valves DN65 to DN100 (2- 1/2 to 4 inch) must be flanged globe valves, and any larger valves must be butterfly valves.
4. Unless otherwise specified the following applies:

a. Bodies for valves DN40 (1-1/2 inches) and smaller must be brass or bronze, with threaded or union ends.
b. Bodies for DN50 (2 inches) valves must have threaded ends.
c. Bodies for valves DN50 to DN75 (2 to 3 inches) must be of brass, bronze, or iron.
d. Bodies for valves DN65 (2-1/2 inches) and larger must be provided with flanged-end connections.
e. For modulating applications, selected valve coefficient must be within 100 to 125 percent of calculated valve coefficient. Valve coefficient must be defined and reported as complete control valve assembly pressure drop, including any and all reducers on all sides of the control valve to make it fit into the pipe size and location orientation, not simply control valve individually on lab test bench with "unlimited" same size straight pipe diameters both upstream and downstream.
f. For two position applications, where two positions are full open and full closed, valve coefficient must be largest available for valve size.
g. Valve and actuator combinations must be normally open or normally closed as shown.
h. Seats, seals and gaskets must be compatible with system working fluids (i.e. EPDM may not be best selection/manufacturer recommended material under certain conditions).
i. Sizing: Size the modulating control valves for water and glycol service for minimum pressure drop of 3-psi (21-kPa) and maximum pressure drop of 5-psi (35 kPa) at design flow rate.

5. Valves that combine the functionality of a standard control valve and a balancing valve, typically referred to as Pressure Independent Control Valves (PICV), are explicitly forbidden. Pressure independent control valves, regardless of if they have been shown on the design drawings, specified in a separate specification section, or called for in an equipment schedule, are not allowed.

B. Ball Valves:

1. Balls: Stainless steel or nickel plated brass.
2. Valves: Blow-out proof stems.
3. In steam and high temperature hot water applications, valve-to-actuator linkage must provide thermal break.

C. Globe Valves:

1. Globe valves must have iron body and bronze or stainless steel seat, stem and plug.
2. Valves: ANSI 125 Class III leakage rating.

D. Butterfly Valves:

1. Butterfly valves must be threaded lug type suitable for dead-end service and modulation to fully-closed position, with carbon-steel bodies and non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -30 to +120 deg C (-20 to +250 deg F) unless not recommended for certain fluid applications.

2. Rated flow coefficient for butterfly valves must be value at 70 percent (60 degrees) open position.
3. Valve Leakage: ANSI/FCI 70-2 Class VI leakage rating.

E. Two-Way Valves:

1. Two-way modulating valves used for liquids must have equal-percentage characteristic (except valves used for bypass, which must have linear characteristic).

F. Three-Way Valves:

1. Three-way modulating valves must provide equal percentage flow control with constant total flow throughout range of modulation.

G. Duct-Coil and Terminal Unit Coil Valves:

1. Provide control valves with either flare-type or solder-type ends for duct or terminal-unit coils.
2. Provide flare nuts for each flare-type end valve.

H. Valves for Chilled Water, Condenser Water, and Glycol Service:

1. Valve Internal Trim: Type 316 stainless steel.

I. Valves for High Temperature, Hot-Water, and Dual Temperature Service:

1. Valves for hot water service between 100 to 120 deg C (210 to 250 degs F) and dual-temperature service must have internal trim (including seats, seat rings, modulating plugs, and springs) of Type 316 stainless steel.
2. Internal trim for valves controlling water below 100 deg C (210 deg F) must be brass, bronze, or Type 316 stainless steel.
3. Non-metallic valve parts must be suitable for a minimum continuous operating temperature of 120 deg C (250 deg F), or 30 deg C (50 deg F) above the system design temperature, whichever is higher.

2.15 CONTROL DAMPERS

A. Dampers: AMCA-rated per 500D, parallel-blade design for 2-position dampers, opposed-blade design for modulating dampers.

1. Frames:

a. [For non-marine applications use following: Minimum of 2.8 mm (0.11-inch) thick, galvanized-steel frames with holes for duct mounting.]

b. [For dampers in moderate or extreme marine corrosion environments with exterior or indirect exposure (see OBO-ICS IBC Appendix W), use the following: Minimum of 2.4-mm thick, extruded aluminum hat channel frames with mounting flanges.]

c. [When the project is located in extreme hot or cold climates, and the application is normally closed for long periods of time (e.g. manual smoke removal): Opposed blade dampers similar to Ruskin CD40x2 insulated for energy conservation.]

d. For control dampers in locations exposed to greater than 22 degrees C (40 degrees F) difference between interior and exterior temperatures (e.g., normally closed smoke removal dampers in return air ducts), provide insulated frame.

1) Basis-of-Design: Ruskin CD40X2 or approved equal.

2. Damper blade:

a. [For non-marine applications use following: Minimum of 1.6 mm (0.063-inch) galvanized steel with maximum blade width of 203 mm (8-inch).]

b. [For dampers exposed to unconditioned outsider air in locations less than 10 km from a seacoast, use the following: Minimum of 1.61-mm thick, heavy gage extruded aluminum damper blades with maximum blade width of 203 mm.]

c. For control dampers in locations exposed to greater than 22 degrees C (40 degrees F) difference between interior and exterior temperatures (e.g., normally closed smoke removal dampers in return air ducts), provide insulated blades.

1) Basis-of-Design: Ruskin CD40X2 or approved equal.

3. Secure blades to 13-mm (1/2-inch) diameter zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
4. Operating temperature Range: From -40 to +93 deg C (-40 to +200 deg F).
5. For standard applications, provide optional closed-cell neoprene edging.
6. Inflatable seal blade edging or replaceable rubber seals rated for leakage at less than 21 L/s per sq. m (4 cfm per sq. ft) of damper area at differential pressure of 250 Pa (1 inch wg) when tested according to AMCA 500D.

2.16 CONTROL WIRE AND CABLE

A. Category 6a copper-wire and OS2 & OM4 fiber-optic cables, for use with BAS Ethernet networks, must conform to the requirements specified in Section 271305 “Communications Backbone Cabling” and in Section 271505 "Communications Horizontal Cabling."

B. Cables for use with BAS RS-485 networks must conform to the following requirements:

1. Cable Type: Twisted, shielded with drain wire; 2, 3 or 4 conductors, as recommended by BAS Manufacturer.
2. Conductor Size: Must be a minimum of 0.326 mm2 (No. 22 AWG).
3. Conductor Type: Twisted, stranded copper
4. Rating: Minimum 300 V and 60 deg C, type PLTC.
5. Flame Resistance: Comply with UL 1685.
6. Maximum Segment Length: 1250 meters (4000 feet).

7. Characteristic Impedance: Between 100 and 130 Ohms
8. Low Capacitance:

    a. Capacitance between conductors: Less than 49 pF/m (15 pF/ft)
    b. Capacitance between conductors and shield: Less than 98 pF/m (30 pF/ft)

C. Wire and cabling for use with inputs, outputs and interlocks must meet the following requirements:

1. Wire: Single conductor control wiring above 24 V:

    a. Conductor Size: Must be a minimum of 0.823 mm^2 (No. 18 AWG).
    b. Conductor Type: Twisted, stranded copper.
    c. Rating: Minimum 600 V and 90 deg C.
    d. Conductor Colors: Conductor colors must be black (hot), white (neutral), and green (ground).

2. Single Twisted Shielded Instrumentation Cable above 24 V:

    a. Cable Type: Twisted, shielded with drain wire; 2 or 3 conductors, as required by application.
    b. Conductor Size: Must be a minimum of 0.823 mm^2 (No. 18 AWG).
    c. Conductor Type: Twisted, stranded copper.
    d. Rating: Minimum 600-V and 90-deg C; Type TC.
    e. Flame Resistance: Comply with UL 1685.
    f. Conductor Colors: For twisted pair, conductor colors must be black and white. For twisted triad, conductor colors must be black, red and white.

3. Single Twisted Shielded Instrumentation Cable 24 V and Less:

    a. Cable Type: Twisted, shielded with drain wire; 2 or 3 conductors, as required by application.
    b. Conductor Size: Must be a minimum 0.326 mm^2 (No. 22 AWG).
    c. Conductor Type: Twisted, stranded copper.
    d. Rating: Minimum 300-V and 105-deg C; Type PLTC.
    e. Flame Resistance: Comply with UL 1685.
    f. Conductor Colors: For twisted pair, conductor colors must be black and white. For twisted triad, conductor colors must be black, red and white.

D. Wire and Cable not installed within raceway must be plenum rated, non-halogenated, low smoke producing as tested in accordance with NFPA 262, “Standard Method of Test for Flame Travel and Smoke Characteristics of Wires and Cables for Use in Air-Handling Spaces.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units and operator workstation.

B. Coordinate availability, location and voltage of power for control panels, user workstation, and any other control devices requiring power with Division 26 sections.

C. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed in accordance with manufacturer recommendations, including clearance and maintenance access.

3.2 INSTALLATION

A. Prohibited Technologies: Hardware that contains prohibited technology must be modified to render inoperable these capabilities.

1. Modifications made to hardware to accomplish this must not negatively impact the base functionality of the product being provided.
2. Hardware must be fully tested after modification to ensure base functionality remains unaltered. When more than one of the same product will be modified, modification and testing must be performed on a sample of the hardware prior to modifying all of that product.

B. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Verify location of temperature, pressure and humidity sensors, and other exposed control sensors with Construction Drawings and room details before installation. Sensors in occupied spaces must conform to accessibility requirements in Chapter 11 of the OBO Building Code (International Building Code as amended by OBO). Coordinated to avoid conflict with interior furnishings.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install Room Security temperature sensors (stainless-steel cover plate) in Public Access Areas.

F. Coordinate location and sizes of automatic dampers.

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures. Where installed in plenum rated areas, install plenum rated motors or actuators, and identify as such in submittal equipment schedule. If damper motor is mounted outdoors, provide a NEMA 4 enclosure with heat where needed by project climate.

H. Install labels and nameplates to identify control components according to Division 23 Section on identification of HVAC piping and equipment.

I. Coordinate location and sizes of hydronic and refrigerant instrument wells, valves, and other accessories according to Division 23 Sections on hydronic piping and refrigerant piping.

J. Coordinate location and sizes of control dampers according to Division 23 Sections specifying air ducts.

K. When underground hydronic piping distribution to other buildings is included in the project design, furnish and install a flow switch in water makeup supply. If flow is detected for more than 3 minutes, program alarm annunciation at BAS head end computer, indicating necessity for Post maintenance to investigate for system leakage.

L. For third party controls interfaced with the BAS (i.e., chiller control panels), ensure their internal sequence is coordinated with the BAS control sequence when necessary.

M. Return and relief air damper actuators must be fully modulating with position end switches unless otherwise noted.

N. Wall sensors for split heat pumps or AC units in Compound Access Control (CAC) facilities, Utility Buildings, and Warehouse/Support buildings must be programmable thermostats with locking covers, capable of non-occupied mode setback per design, and to avoid tampering.

O. Install all flow meters (both air and water) in accordance with manufacturer's requirements for upstream and downstream pipe diameters to achieve specified flow accuracy.

P. Control valves larger than 63 mm (2-1/2 inches) must be installed with full-sized maintenance bypass valve and piping.

Q. Install building pressurization sensors for controlling and reporting zone pressures in occupied spaces, not in corridors.

R. Zone pressure sensing probes must not be located near mailroom exhaust, kitchen hood exhaust, AHU return ducts, medical lab exhaust hoods, or other sources of positive or negative pressure which will adversely affect the stability and accuracy of the sensor readings.

S. Install duct-mounted CO_2 sensors on sides or tops of ducts while remaining accessible.

3.3 WIRE, CABLE AND RACEWAY INSTALLATION

A. Comply with NECA 1, "Standard for Good Workmanship in Electrical Construction".

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 260518, "Low-Voltage Electrical Power Conductors and Cables."
2. Comply with installation requirements in Section 271113, "Communication Entrance Protection."
3. Comply with installation requirements in Section 271305, "Communications Backbone Cabling."
4. Comply with installation requirements in Section 271505, "Communications Horizontal Cabling."

5. Conceal wire and cable, except in mechanical rooms and areas where other conduit and piping are exposed.
6. All wire and cable, located in exposed or concealed spaces, must be installed in raceway.

    a. Exception: Plenum rated cable not installed in raceway may be used in concealed plenum spaces in offices for use with wall mounted sensors.
    b. Clearly identify cables not installed in raceway through use of unique cable color.

7. Install network cabling in dedicated raceway separate from all other wires and cables used for other purposes. Splices in network cabling are not allowed.
8. For each sensor, input or output device, provide single cable from sensor or device directly to associated controller. Each cable must include quantity of conductors required for specific sensor or device. Sharing of conductors for multiple sensors is not permitted. Splices in cable between the sensor or device and controller are not allowed.
9. Use cables with shielding for wiring associated with analog signals. Ground drain wires from shielded cables (not including network cables) to controller enclosure as close as possible to point of entry.
10. Do not run control wiring within raceways containing wiring at 120 volts or above.
11. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
12. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
13. Clearly label all control wiring and cables for future identification and servicing of BAS. Label wires and cables at each end and at each junction box or enclosure they pass through with these identification labels. Label cables run outside of raceways every two meters. Labels must be vinyl, self-laminating flag type, and large enough to include four lines of text. Print the following information, as shown in BAS “As-Built” documents, on each label.

    a. Input/Output Wiring

        1) Control Panel ID
        2) Unique Point ID
        3) Controller I/O Used
        4) Unique Wire/Cable Designation

    b. Interlock Wiring

        1) From Location ID
        2) To Location ID
        3) Unique Interlock ID
        4) Unique Wire/Cable Designation

    c. Network Wiring

        1) From Controller/Equipment ID
        2) To Controller/Equipment ID
        3) Network ID

4) Unique Wire/Cable Designation

d. Power Wiring

1) Control Panel ID
2) Transformer/Power Supply ID
3) Voltage
4) Unique Wire/Cable Designation

14. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
15. Use fiber optic cable for all network runs between buildings.
16. Perform continuity and megger testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with installation requirements in Section 260533, "Raceways and Boxes for Electrical Systems."
2. Minimum conduit size must be 20 mm (¾ inch) unless connecting to an end-of-line device with a factory connection size of smaller diameter (e.g., 12 mm (½ inch)).
3. Run BAS network between buildings in dedicated conduit with other conduits in concrete-encased conduit bank. Fiber and wiring from other BMS are not permitted to share the BAS conduits.
4. Enclosures, junction boxes and raceway associated with the BAS must be clearly identified as part of the BAS. Covers to BAS junction boxes must be painted light blue. Raceway must be labeled with five-centimeter-long light blue markings at a distance of every two meters.

D. Grounding: Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

E. Manual Reset Limit Controls: Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Hand-Off-Auto Switches: Connect hand-off-auto selector switches to override automatic controls when switch is in hand position.

3.4 TRENDING FUNCTIONALITY

A. Develop trending functionality of system.

1. Set up trends for each system per BAS Point List Tables in Part 3, Article POINT LIST SCHEDULE. The trend list may be modified based on input from OBO/PDCS/DE project team Mechanical Engineer or project Commissioning Agent. Trends will be similar to the following:

a. Building Pressurization: Graph all differential pressure readings and set points collected at 15 minute intervals.
b. Chilled Water Temperature: Graph all chilled water supply and return temperatures at 10 minute intervals.
c. Critical Room Space Temperature: Graph all space temperatures for Joint Unclassified Computer Room (JUCR), Main Telephone Equipment Room (MTER), Electrical Closet (EC), Radio Network Equipment Room (RNER), Multi-purpose room, and similar rooms at 30-minute intervals

B. Trend Data Storage:

1. Trend data must be stored at Digital Control Unit for the associated trended sensor, and uploaded to OW for archiving. Uploads must occur based on either user-defined interval, manual command, or when Digital Control Unit trend buffers becomes almost full. Uploads must be setup to execute without loss of trend data. All trend data uploaded to the OW must be kept for a minimum of five years (first year plus four consecutive years). All stored trend data must be available in format usable by Microsoft Excel.

3.5 REPORTING FUNCTIONALITY

A. Develop reporting functionality of system.

1. Set up maximum of ten reports. These reports will be identified by Project Director/COR with input from either Post Facility Manager or OBO/PDCS/DE project team Mechanical Engineer. Trends will be similar to the following:

a. Energy Usage: Create report to show electrical usage for compound and each building organized by month, with annual summary.
b. Fuel Usage: Create report to show fuel usage for compound and each building organized by month with annual summary.
c. Water Usage: Create report to show water usage for compound and each building organized by month with annual summary.

3.6 TESTING, CALIBRATION, AND ACCEPTANCE, GENERAL

A. Space Pressure Control and Monitoring Sensors:

1. Manufacturer or factory-trained representative must perform start-up, including calibration of monitors and sensors. Perform calibration only after ceiling and doors are installed and HVAC systems are properly air-balanced.
2. Install monitor panels on secure side of building hardlines.
3. Refer to Construction Drawings for additional requirements.
4. Protect all ends of tubing during construction with temporary caps or plugs to prevent contamination. Blow out all tubing with compressed air prior to connection to any equipment panels or sensors. Provide pressure test at 14 kPa (2 psig) for 2 hours to prove tubing system integrity and include report in Quality Control documentation.

3.7 FIELD QUALITY CONTROL

A. Contractor Verification and Validation: Testing described in this section is the sole responsibility of BAS subcontractor. BAS subcontractor must develop required testing plans, must perform verification and validation testing in accordance with these testing plans, and must prepare reports documenting results of testing performed. This work is to be performed in addition to and independently from the third party Commissioning process. It is BAS subcontractor's responsibility to verify and validate their own work before certifying to the Government and the Commissioning Agent that the BAS is ready for Commissioning Testing.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing.

C. DDC Verification Testing: The purpose of verification testing is to demonstrate "completeness" of physical tasks associated with installation and "error-free" performance of components.

1. At a minimum perform the following verification checks prior to energizing each control panel.

a. Verify integrity and quality of connections (loose strands and tight connections).
b. Verify bus topology, grounding of shields and installation of termination devices.
c. Verify proper controller power wiring.
d. Verify that controller power supply is from emergency power supply, if applicable.
e. Verify that controllers and computers are protected from power supply voltage surges and fluctuations.
f. Verify that wires at control panels are tagged with their service designation and approved tagging system.
g. Verify labeling on components and wiring is correct; matches the labeling used in approved submittals and matches labeling used in operator workstation graphics.
h. Verify component inventory as compared to approved submittals.
i. Verify that instruments are installed before calibration, testing, and loop or leak checks.
j. Check instruments for proper location and accessibility.
k. Check instrument installation for correct direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
l. Check flow instruments. Inspect tag number and line and bore size and verify that inlet side is identified and that meters are installed correctly.
m. Check pressure instruments, piping slope, installation of valve manifold, self-contained pressure regulators, and length of pneumatic tubing runs connected to zone differential-air-pressure sensors.
n. Check temperature instruments. Verify material and length of sensing elements.
o. Check control valves:

1) Verify that valve is installed in correct direction.
2) Verify actuator is specified for fail-safe position and jumper/switch settings or mountings are not reverse acting unless necessary.

3) Verify that valve does not allow fluid flow when commanded to fully closed position under system operating pressure.

p. Check dampers:

1) Verify that proper blade alignment, either parallel or opposed, has been provided.
2) Verify that actuator is mounted properly to duct (alignment).
3) Verify that actuator is securely fastened to shaft (does not spin without shaft movement and is ranged properly for fully open/closed position).
4) Without actuator attached verify that damper operates freely, without dragging, when shaft is rotated by hand.

q. Verify that space for spare I/O capacity has been provided.

2. The following verification checks must be performed after energizing each control panel.

a. Measure voltage sources, primary and secondary.
b. Verify each I/O device is landed in accordance with submittals.
c. Verify analog sensors are properly scaled and correct value is reported.
d. Verify analog outputs have correct normal position and move full stroke when so commanded.
e. Verify digital sensors have correct normal position, and state is correctly reported.
f. Verify digital outputs have correct normal state and respond appropriately to energize/de-energize commands.

3. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

D. Operator Interface Verification Testing: Perform verification testing to confirm graphics are complete, user interface is configured, and both are fully operational on each operator workstation (desktop and laptop computers). Test elements must require verification of all operator interaction tasks including, but not limited to, the following:

1. User account access and configuration.
2. Graphics navigation.
3. Trend data collection and presentation.
4. Alarm handling, acknowledgement, and routing.
5. Time schedule editing.
6. Application parameter adjustment.
7. Manual override control.
8. Report execution.
9. Automatic backups.
10. Web Client access.

E. DDC Validation Testing: The purpose of validation testing is to ensure that the system performs in accordance with the sequences of operation. For each distinct control function include a series of step-by-step cause-and-effect tests to verify each aspect of the sequences of operation.

1. Validation testing must be witnessed by representative of the OBO/PDCS/DE project team, BAS Engineer, and project Commissioning Agent. Schedule validation testing with Project Director/COR.
2. After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties.
4. Test and adjust smoke and fire/smoke dampers.
5. Test and adjust purge system.
6. Test each point through its full operating range to verify that safety and operating control set points are as required.
7. Test each control loop to verify stable mode of operation and compliance with sequences of operation. Adjust PID actions.
8. Test each system for compliance with sequence of operation.
9. Test software and hardware interlocks.
10. Cooling and heating functionality must be tested during their applicable season of operation, winter for heating and summer for cooling.
11. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

F. Building Accreditation Testing: Prior to building accreditation testing by Diplomatic Security (DS) the BAS subcontractor must certify to the Government that all control wiring, controllers, and equipment have been installed, that entire BAS has been energized, and that BAS network is complete and functioning.

3.8 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers, following manufacturer's recommended procedure, so that valve or damper is verified 100 percent open and fully closed.
9. Provide diagnostic and test instruments and gases for calibration of devices and adjustment of system.
10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures for review and approval before initiating startup procedures.

B. Adjust initial temperature, night/unoccupied set back temperatures, humidity, CO_2 and pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide an additional five-day visit to Project for this purpose.

3.9 TESTING, ADJUSTING AND BALANCING (TAB) FOR HVAC

A. BAS subcontractor must work in close cooperation with TAB subcontractor in calibrating all air flow measuring stations, water flow meters, duct and pipe mounted differential pressure sensors/transmitters and zone differential pressure sensors/transmitters.

B. BAS subcontractor must facilitate testing, adjusting and balancing process, as described in Section 230593 “Testing, Adjusting, and Balancing for HVAC”, by:

1. Providing TAB subcontractor with software and tools necessary to interface with control system to test, adjust and balance controlled HVAC systems.
2. Training TAB subcontractor on use of provided software and tools.
3. Providing qualified BAS technician to assist with testing, adjusting and balancing process. Assistance must include but not be limited to:

   a. Providing and implementing global system commands to set VAV boxes, dampers and control valves to maximum, minimum or other positions as required for balancing.
   b. Adjusting system settings such as air flow coefficients, fan speeds, static pressure set points and damper limits to set HVAC systems to design requirements.

C. Air flow coefficients for terminal boxes must be initially set by BAS subcontractor before TAB subcontractor begins work. Air flow coefficients must then be field tested, verified and adjusted by TAB subcontractor to ensure that actual air flow and monitored air flow match.

D. Pressure set points for air distribution systems and hydronic distribution systems must be initially set by BAS subcontractor before TAB subcontractor begins work. Pressure set points must then be field tested, verified and adjusted by TAB subcontractor.

3.10 COMMISSIONING

A. BAS subcontractor must fully participate in the Commissioning process. All necessary support must be provided to the Commissioning Agent to perform project commissioning as described in Section 019115, “Commissioning” and Section 230805, “Commissioning of HVAC”.

B. Section 019115 “Commissioning” identifies general commissioning processes and procedures, as well as roles and responsibilities for all Commissioning Team members. Section 230805 “Commissioning of HVAC” supplements the general requirements specified in Section 019115.

C. Commissioning requirements include but are not limited to: Pre-Functional Checks, Point-to-Point Checks, Startup, Functional Performance Tests, Integration Tests, etc.

D. The Commissioning process does not replace or substitute for BAS subcontractor’s own verification and validation testing.

1. Testing and other activities associated with the Commissioning process are in addition to verification and validation testing required by this Section.
2. Pre-Functional Checklists, Point-to-Point Checklists, Functional Performance Tests, Integration Tests and other testing documents and reports developed by Commissioning Agent and supplied to BAS subcontractor for use in Commissioning activities are in addition to BAS subcontractor developed verification and validation testing plans and reports required by this Section.

E. Pre-Functional Checklists and Point-to-Point Checklists are to be completed and provided to TAB subcontractor prior to start of field work identified in Section 230593 “Testing, Adjusting and Balancing for HVAC.”

3.11 DEMONSTRATION

A. Factory-trained service representative must train Government's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. 40 hours of training must be performed. Refer to Division 01 Section "Demonstration and Training."

3.12 SOFTWARE AND HARDWARE TURNOVER

A. Installation Software Turnover: All installation disks (DVDs or CDs) and licenses for software installed on each OW (BAS Software, Production Software and Operating System Software) and

controller must be turned over to the Government for use in rebuilding an OW or controller after catastrophic failure; this must occur for each BAS installed at post. In addition, perform the following:

1. Give post Facility Maintenance staff all software required to rebuild an OW or Controller from scratch in event of hardware failure.
2. Provide step-by-step instructions describing process for disk installation of each software package and/or driver.
3. Deliver second copy of software and associated licenses to OBO/OPS/FAC "BAS Support" for centralized backup by OBO.
4. Provide one year of system support.

B. BAS Backup Turnover: The BAS Contractor, after commissioning has been completed, must create a current backup of the data, programming, graphics, settings, license files, and any other files necessary to restore a controller, OW or Server. This must be done for each BAS installed at Post. In addition, perform the following:

1. Configure each backup to allow Facility Maintenance staff to recover associated BAS controller, OW, or Server in event there is BAS failure.
2. With each backup, provide step-by-step instructions on how to recover a controller, OW or Server.
3. Deliver second copy of all BAS backup to "BAS Support" for centralized backup by OBO.

C. [Recovery of Existing BAS Hardware: When BAS is replaced or renovated, Contractor must ship all functional existing Operator's Workstations and existing Controllers from Post to OBO "BAS Support". Care must be taken in the removal and packing of the BAS equipment to avoid causing damage.]

3.13 POINT LIST SCHEDULE

A. The following scheduled point lists for air handlers, chilled water (CHW) systems, hot water (HW) systems, variable air volume (VAV) terminal units, and for other miscellaneous systems presented, identify minimum requirements for the control system to the Designer of Record (DOR). The DOR is responsible for generating Issue For Construction (IFC) design documents that incorporate these minimum requirements into the drawings. Refer to the Part 1 Article on SYSTEM PERFORMANCE for requirement to supplement points based on project design. DOR must delete Part 3 Article POINT LIST SCHEDULE from the 230905 specification before IFC design documents are generated.

TABLE 3.13.1
SYSTEM POINT LIST

AIR HANDLERS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
VAV AIR HANDLERS	X								Diagrammatic system graphic (each)
Fan Start/Stop					X			X	
Fan Status				X		X	X	X	
Fan VFD Speed			X					X	
Fan VFD Speed Feedback		X						X	
Fan VFD Failure				X		X			
High Static Pressure				X		X			Hard wire to fan VFD
Low Static Pressure				X		X			Hard wire to fan VFD
CHW Valve			X					X	
OA/Return Air Damper			X					X	
Discharge Temperature		X						X	
Discharge Humidity		X						X	
Duct Static Pressure		X						X	
Outside Air Flow		X						X	
Mixed Air Humidity		X				X		X	
Return Air Temperature		X						X	
Return Air Humidity		X						X	
Return Air CO^2		X				X		X	
Pre-Filter Differential Pressure		X				X		X	
HEPA Filter Differential Pressure		X				X		X	
HEGA Filter Differential Pressure		X				X		X	
Space CO^2 (each)		X				X		X	
Space Differential Pressure (each)		X				X	X	X	Note 1
Space Relief Air Damper			X					X	
Space Smoke Exhaust Damper					X			X	
Airflow (OA & Discharge Air)		X				X		X	Discharge airflow monitor from AHU mfr

TABLE 3.13.1
SYSTEM POINT LIST

AIR HANDLERS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
SA/RA Smoke Detector (each)				X		X	X		
Fire Alarm System				X		X			
OUTSIDE AIR HANDLER	X								Diagrammatic System Graphic
Outside Temperature		X						X	
Outside Humidity		X						X	
Outside Air Damper w/End Switch					X	X		X	
Pre-Filter Differential Pressure		X				X		X	
Carbon Filter Differential Pressure		X				X		X	
Heating Coil Valve			X					X	
Cooling Coil Valve			X					X	
Low Temperature Limit				X		X			Hard wire to fan VFD
Fan Start / Stop					X			X	
Fan Status				X		X	X	X	
Fan VFD Speed			X					X	
Fan VFD Speed Feedback		X						X	
Fan VFD Failure				X		X			
High Static Pressure				X		X			Hard wire to fan VFD
Low Static Pressure				X		X			Hard wire to fan VFD
Duct Static Pressure		X						X	
Discharge Temperature		X				X		X	
Discharge Humidity		X				X		X	

GENERAL NOTES:
Note 1: Alarm at Post 1, Post 2 if in Alarm for more than 5 Minutes

TABLE 3.13.2
SYSTEM POINT LIST

CHW SYSTEM

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
CHW SYSTEM	X								Diagrammatic system graphic
CHW PUMPS	X								Use for all Variable Speed Pumps
CHW Pump Start / Stop					X			X	
CHW Pump Status				X		X	X	X	Alarm at Post 1, Post to if all Pumps Fail
CHW Pump Speed			X					X	
CHW Pump Speed Feedback		X						X	
CHW Pump VFD Failure				X		X	X		Alarm at Post 1, Post to if all Pumps Fail
CHW SYSTEM - GENERAL	X								
CHW Supply Temperature		X				X		X	Note 1, (High and Low Temp. Alarm)
CHW Return Temperature		X				X		X	Note 1, (High and Low Temp. Alarm)
Remote CHW Differential Pressure		X				X		X	
Local CHW Differential Pressure									DP located at the plant
CHW Bypass Valve		X						X	Variable primary system
CHW Flow		X				X		X	
CHW Makeup Flow Switch				X					
CHILLER (EACH)	X								**Diagrammatic system graphic**

TABLE 3.13.2
SYSTEM POINT LIST

CHW SYSTEM

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
Chiller Enable / Disable					X			X	Must be Hardwired, not Communicated
Chiller Status				X		X		X	Must be Hardwired, not Communicated
Chiller General Alarm				X		X	X		Must be Hardwired, not Communicated
Chiller KW/Ton		X						X	May be Communicated
Compressor Failure (each)				X		X			May be Communicated
Chiller Power Usage		X						X	kWH may be Communicated
Chiller RLA		X						X	Amps may be communicated
Chiller Runtime		X						X	May be Communicated
HEAT EXCHANGER	X								
HX Supply Temperature (Building Side)		X				X		X	
HX Return Temperature (Building Side)		X						X	
HX Isolation Valves (all)					X			X	
CHEMICAL TREATMENT	X								Coordinate w/CHWS
General Alarm				X		X			

GENERAL NOTES:
Note 1: Setpoint Control from Chiller Panel

TABLE 3.13.3
SYSTEM POINT LIST

HW SYSTEM

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
HW SYSTEM	X								Diagrammatic system graphic
HW PUMPS	X								Use for all Constant Volume Pumps
HW Pump Start/Stop					X			X	
HW Pump Status				X		X	X	X	Alarm at Post 1, Post 2 if all pumps fail
HW PUMPS W/ VFD	X								Use for all Variable Speed Pumps
HW Pump Start/Stop					X			X	
HW Pump Status				X		X	X	X	Alarm at Post 1, Post 2 if all Pumps fail
HW Pump Speed			X					X	
HW Pump Speed Feedback		X						X	
HW Pump VFD Failure				X		X	X		Alarm at Post 1, Post 2 if all Pumps fail
HW SYSTEM - GENERAL	X								
HW Supply Temperature		X				X		X	High and Low Temp. Alarm
HW Return Temperature		X				X		X	High and Low Temp. Alarm
HW Differential Pressure		X				X		X	
HW Flow		X				X		X	
BOILER (EACH)		X							Diagrammatic system graphic
Boiler Enable/Disable					X			X	Must be Hardwired, not Communicated
Boiler Status				X		X		X	Must be Hardwired, not Communicated

TABLE 3.13.3
SYSTEM POINT LIST

HW SYSTEM

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
Boiler General Alarm				X		X	X		Must be Hardwired, not Communicated
Boiler Fuel Usage		X						X	
Boiler Type of Fuel				X				X	Natural Gas or Fuel Oil
Boiler Efficiency		X						X	BTUH may be communicated
Outside Air Temperature		X						X	
Boiler Pump Start/Stop					X			X	
Boiler Pump Status				X		X	X	X	
HWS Supply and Return Temperature		X				X		X	High and Low Temp. Alarm
HWS Flow		X				X		X	
HEAT RECOVERY CHILLERS	X								If Installed on Project
Circulating Pumps (each)	X								
Pump Start/Stop					X			X	
Pumps Status				X		X		X	
CHW Supply Temperature		X						X	
CHW Return Temperature		X						X	
HW Supply Temperature		X						X	
HW Return Temperature		X						X	
Isolation Valves (each)					X			X	
Chiller Enable/Disable					X			X	Must be Hardwired, not Communicated
Chiller Status				X		X		X	Must be Hardwired, not Communicated
Chiller General Alarm				X		X			Must be Hardwired, not Communicated
Chiller KW/Ton		X						X	May be Communicated
Compressor Failure (each)				X		X			May be Communicated
Chiller Power Usage		X						X	KWH may be Communicated

TABLE 3.13.3
SYSTEM POINT LIST

HW SYSTEM

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
Chiller RLA		X						X	Amps may be Communicated
Chiller Runtime		X						X	May be Communicated
CHEMICAL TREATMENT	X								Coordinate w/ CWS
General Alarm				X		X			
GENERAL NOTES:									

TABLE 3.13.4
SYSTEM POINT LIST

VARIABLE AIR VOLUME TERMINAL UNITS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
AIR DISTRIBUTION SYSTEMS	X								Floor plan zone graphic
VAV Terminal Units (each)	X								Diagrammatic graphic for each unit
Zone Temperature		X				X	X	X	High and Low Alarms (Note 1)
Cooling Setpoint			X					X	
Heating Setpoint			X					X	
Damper			X					X	
HW Valve			X		X			X	BO if Tri-State Valve
Electric Heat			X		X			X	BO if Step Heaters
Air Flow		X				X		X	
Min. CFM Set Point			X						
Max. CFM Set Point			X						
Heating Min. CFM Set Point			X						
Heat Status				X				X	
Discharge Temperature		X						X	
Unoccupied Cooling Temp. Setpoint			X					X	
Unoccupied Heating Temp. Setpoint			X					X	
Damper Override					X	X			
Heat Override					X	X			
Max. Zone Temp. Group		X				X		X	
Min. Zone Temp. Group		X				X		X	
Avg Zone Temp. Group		X						X	
Total Group Flow		X						X	

GENERAL NOTES:
Note 1: Alarm High and Low Temp. alarms at Post 1 and Post 2 for all critical spaces (JUCR, EC, MTER, RNER)

TABLE 3.13.5
SYSTEM POINT LIST

MISCELLANEOUS SYSTEMS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
EXHAUST FANS / PRESSUR'N FANS (EACH)	X								Diagrammatic system graphic
Fan Start/Stop					X			X	
Fan Status				X		X	X	X	Note 1
Fan Speed			X					X	
Fan Speed Feedback		X						X	
VFD Failure				X		X	X		Note 1
Duct Static Pressure		X						X	
Damper (2-Pos)					X				
Damper (Modulating)			X					X	
FAN COIL UNITS	X								Diagrammatic system graphic
Fan Start/Stop					X			X	
Fan Status				X		X		X	
Chilled Water Valve			X					X	
Space Temperature		X				X		X	
COMPUTER ROOM A/C	X								Diagrammatic system graphic
Space Temperature		X				X	X	X	
General Alarm				X		X	X		
SPLIT SYSTEM A/C	X								Diagrammatic system graphic
Space Temperature		X				X		X	
General Alarm				X					
VRF/VRV SYSTEMS	X								
Unit On/Off Status				X				X	
On/Off					X			X	
Mode of Operation				X				X	

TABLE 3.13.5
SYSTEM POINT LIST

MISCELLANEOUS SYSTEMS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
Space Temperature		X						X	
Alarm Signal				X		X			
LOBBY/ PAA SPECIAL SYSTEMS	X								TBD
GENERATORS	X								Diagrammatic system graphic
General Alarm				X		X	X		
Tank Fuel Level (each)		X				X	X	X	High and Low Level
Fuel Pump Status (each)				X		X	X	X	
Generator Status (On/Off) (each)				X		X	X	X	Totalize Run Time
FUEL SYSTEM	X								
Fuel Tank Level (each)		X				X	X	X	High and Low Level
Leak Detection (each)				X		X	X		
Enable/Disable					X			X	
Pump Status (each)				X		X		X	
General Alarm				X		X	X		
WATER FILTRATION/ BOOSTER PUMPS	X								Diagrammatic system graphic
General Alarm				X		X	X		
PH Level Main Potable water pipe and each Tank		X				X		X	High and Low Level Alarms
Turbidity Level Main Potable water pipe and each Tank		X				X		X	High level Alarms

TABLE 3.13.5
SYSTEM POINT LIST

MISCELLANEOUS SYSTEMS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
Chlorine Level Main Potable water pipe and each Tank		X				X		X	High and Low Level Alarms
TDS Level Main Potable water pipe and each Tank		X				X		X	High and Low Level Alarms
Hardness Level Main Potable water pipe and each Tank		X				X		X	High and Low Level Alarms
Alkalinity Level Main Potable water pipe and each Tank		X				X		X	High and Low Level Alarms
Temperature Main Potable water pipe and each Tank		X				X		X	High Level Alarm
Pressure Main Potable water pipe and Raw Water pipe		X				X		X	High and Low Pressure Alarms
Filtration Module Diff. Pressure (each)		X				X		X	High Level Alarm
Chlorine Tank Level		X				X		X	Low Level Alarm
pH/Corrosion control additive 1 Tank Level		X				X		X	Low Level Alarm
Corrosion control additive 2 Tank Level		X				X		X	Low Level Alarm
Tank Level (Each Tank)		X				X	X	X	High and Low Level Alarms
Pump Status (each)				X		X	X	X	
Low Pressure Cut-Off				X		X	X	X	
WATER METERING	X								Diagrammatic system graphic
Water Consumption		X						X	Compound and per Building

TABLE 3.13.5
SYSTEM POINT LIST

MISCELLANEOUS SYSTEMS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
FUEL METERING	X								Diagrammatic system graphic
Fuel Consumption (fuel oil and gas)		X						X	Compound and per Building (May be based upon equipment consumption)
ELEVATORS	X								
General Alarm				X		X			Each Building
LABORATORY FUME HOOD (EACH)	X								
Enable/Disable					X			X	
Status				X		X		X	
FIRE ALARM	X								
Points as Needed						X	X		Points as Needed for Smoke Sequences
SEWAGE PUMPS	X								
Status (each)				X		X		X	
High Water Level Alarm				X		X	X		
SUMP PUMPS	X								
Status (each)				X		X		X	
High Water Level Alarm				X		X	X		
SOLAR HOT WATER	X								
Energy Total		X						X	Communicated from BTU meter
Energy Rate		X						X	Communicated from BTU meter

TABLE 3.13.5
SYSTEM POINT LIST

MISCELLANEOUS SYSTEMS

SYSTEM POINT DESCRIPTION	GRAPHICS	ANALOG		BINARY		ALARMS		TRENDS	NOTES
		INPUT (AI)	OUTPUT (AO)	INPUT (BI)	OUTPUT (BO)	AT BAS OW	AT POST 1 & 2		
Flow Total		X						X	Communicated from BTU meter
Flow Rate		X						X	Communicated from BTU meter
Supply Temperature		X						X	Communicated from BTU meter
Return Temperature		X						X	Communicated from BTU meter
Pump Status				X				X	
General Alarm				X		X			
POWER MONITORING	X								Diagrammatic system graphic
Power Consumption		X						X	Compound and Per Building
POWER MONITORING SYSTEM	X								
Points as Needed									Communicated Points per Specs
COMPRESSED AIR SYSTEM	X								
General Alarm				X		X			Communicated or wired

GENERAL NOTES:
Note 1: Alarm Pressurization fans failures at Post 1 and Post 2

END OF SECTION 230905

SECTION 234105 - AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate and gaseous matter from air for HVAC applications not served by Section 237315 Central Station Air Handling Units. (for example, Fan Coil Units filters or AHU filters for on-compound outbuildings serving spaces without offices (warehouses/shops) or residences,

B. Related Sections include the following:

1. See Section 237315 “Central-Station Air-Handling Units” for filtration requirements in areas with environmental security protection (chem/bio protection).

1.2 DEFINITIONS

A. [HEPA: High-efficiency particulate air.]

B. [HEGA: High-efficiency gas adsorption.]

C. MERV / MERV A: Minimum Efficiency Reporting Value; “A”: per ASHRAE Standard 52.2 MERV “A:” has been adopted to clarify performance degradation of filters that rely on electrostatic and similar mechanisms to achieve higher MERV rating that subsequently degrades after initial operation.

1.3 SUBMITTALS

A. Product Data: Include dimensions and weights; operating characteristics (e.g., particulate MERV / MERV A rating, gas adsorption residence time, temperature and humidity operating and storage limits); required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; collection efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.

1. Show filter rack assembly, dimensions, materials, methods of assembly of components, and appurtenances required for project conditions and design (e.g., lifts, test ports, p-traps, electronic trap primer for special conditions).

2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

C. Calculations: Provide particulate and gaseous media selection and lifecycle calculations based upon local pollutants (e.g., agicn.org) and EPA IAQ standards for worst case scenario per National Air Filtration Association (NAFA) Guide to Air Filtration.

D. Operation and Maintenance Data: Provide emergency, operation, and maintenance manuals for each type of filter and filter rack. Include recommended change-out schedule and replacement procedure based upon contaminant concentration levels and local environmental conditions.

E. Reports: Final, certified test reports for field and factory testing, including HEPA and HEGA testing where applicable, must be provided to the Project Director/COR for forwarding to OBO/PDCS/DE/ME for approval and to OBO/OPS/FAC for inclusion in the Maintenance Database.

1.4 QUALITY ASSURANCE

A. [Basis of Design: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Other manufacturers systems with equal performance characteristics may be considered.]

B. Comply with NFPA 90A and 90B.

C. Comply with ASHRAE 52.2 for methods of testing and rating air-filter units.

D. Comply with ASHRAE RP-671.for critical IAQ air filtration applications.

E. [Comply with IEST-RP-CC001.3 for HEPA filters]

F. [Comply with IEST-RP-CC008 for gas phase adsorber cells.]

G. [Comply with applicable sections of ASME N509 for high efficiency air cleaning devices.]

H. [Comply with applicable ASME AG-1 for HEPA and HEGA filters.]

1.5 DELIVERY AND STORAGE

A. Delivery: Filters must not be shipped installed in air handling unit filter housing. Filters must be packaged in sealed heavy duty plastic to protect from moisture during shipping and storage, and securely placed in heavy cardboard boxes to protect filters from damage during shipping. Filter manufacturer and model number must be labeled on outer most packaging.

B. Handling and Storage: Filters must be carefully handled and stored in dry space, safe from inadvertent construction damage, until ready for installation. Filters must be stored at temperature and humidity within allowable ranges established for filter operation by manufacturer.

1.6 EXTRA MATERIALS

A. Furnish extra material described below that match the products installed that are packaged and labeled for storage as described in the Part 1 Article on DELIVERY AND STORAGE.

1. For non-custom air handling units, provide one complete set of replacement filters for each AHU. This set of filter is in addition to all filters required for construction and initial occupancy.
2. For fan coil units (FCU), provide three sets of replacement filters for each FCU - one to be installed at the end of the project and two sets of filters to be turned over to Post. These three sets of filters are in addition to all filters required during construction and for initial occupancy.

PART 2 - PRODUCTS

2.1 CONSTRUCTION FILTERS

A. ASHRAE 52.2 MERV 11/11A filter is the minimal acceptable construction filter for air handling unit. ASHRAE 52.2 MERV 8/8A filter is the minimal acceptable construction filter rating for various types of fan coil units.

2.2 EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS AND BAG FILTERS

A. Description: High efficiency disposable filter in enclosing frame, sizes as [noted on Drawings].

B. Efficiency: ASHRAE 52.2 MERV 13/13A[or greater as required by contract documents].

C. Media: Fibrous material formed of moisture resistant, microfine glass formed into uniformly spaced close pleat and held by self-supporting wire grid. Filter must be capable of withstanding 2.5 kPa without failure of the media pack. Electrostatic media must not be used to achieve the required particle capture performance.

D. Media and Media-Grid Frame: The filter frame/media pack assembly must be constructed to ensure a rigid and durable filter.

2.3 [HEGA /ADSORPTION FILTERS FOR NON-AHU APPLICATIONS

A. Description: Use one or more adsorption filters as required to conform to U.S. EPA National Ambient Air Quality Standards (NAAQS) and Indoor Air Quality (IAQ) standards for removal of gaseous industrial air pollutants. Use historical data on outdoor air quality from the local area or nearest airport to determine the optimum filter selection. Filter set must be factory fabricated adsorption media trays in deep-V formation.

B. Media: Adsorption media (e.g., activated carbon, impregnated carbon) mounted in removable trays. Media must be sized based upon capacity of airflow; [W.W] kg ([X.X] lb) of activated carbon per [YYY] L/s ([ZZZ] cfm)). Comply with the media manufacturer's recommendations for the media application.

C. Media Frame: If relative humidity level in air remains below 70 percent, disposable epoxy coated frames are acceptable. If relative humidity level rises above 70 percent, install rechargeable plastic or stainless steel frame.

D. Housing: 1.6mm- (0.064 inch) thick, galvanized steel; for side servicing through gasketed access side doors. Equip housings with metal slide channel tracks to hold adsorption media trays. Where outdoor humidity exceeds 12 g water per Kg of dry air, provide provision for removing excess moisture upstream of HEGA media.

E. Post Filters: Provide minimum MERV 8 post filters downstream of adsorption media filters where recommended by manufacturer to capture adsorption media fines.

F. Mounting Frames: Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter. Filter frame and housing must incorporate knife-edge fluid seal design that mates into a fluid-filled perimeter channel on mounting face of filter. Weld seams and joints that are adjacent to any portion of any gasket-sealing surface must be ground smooth and flush with adjacent metal surfaces.]

G. HEGA Filters: Fabricate and label in accordance with IEST-RP-CC008 for gas phase adsorber cells.

H. HEGA Test Canister: Replaceable, threaded 50-mm dia. test canisters, as recommended by filter manufacturer.]

2.4 [HEPA FILTERS

A. Description: Each HEPA Filter must be fabricated and labeled as 99.97 percent dust spot efficiency (ASHRAE 52.2 MERV 17 and higher) per IEST RP-CC001 for Type A performance and Grade 2 construction. The filter pack must be constructed by pleating a continuous sheet of filter media per IEST RP-CC001 for Type a performance and Grade 2 construction.

1. Fabricate and label in accordance with applicable sections of both ASME N509 High Efficiency Air Cleaning Devices, IEST-RP-CC008 for gas phase adsorber cells, and ASME AG-1 Code on Nuclear Air and Gas Treatment.

B. Media: UL 586, fibrous glass, constructed of continuous sheets with closely spaced pleats to remove 99.97 percent of all particulate matter 0.3 microns or greater.

C. Media to Frame Side Bond: Polyurethane foam.

D. Face Gasket: Self healing, non-flowing elastomeric gel sealant.

E. Filter Guard: Provide an expanded metal grille over exposed HEPA filter material that does not interfere with filter operation.

F. Mounting Frames: Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter. Filter frame and housing must incorporate knife-edge fluid seal design that mates into a fluid-filled perimeter channel on the mounting face of the filter. All weld seams and joints that are adjacent to any portion of any gasket-sealing surface must be ground smooth and flush with the adjacent metal surfaces.]

2.5 REPLACEABLE TYPE FILTERS

A. Description: Replaceable type filters are to be used in fan coil units and heat pump/split systems. An ASHRAE 52.2 MERV 8 filter is the minimal acceptable filter rating.

B. Media: UL 900 fiber in fiberboard casings, thickness 25-50 mm as applicable to equipment to be installed on.

C. Media Frame: Media must be within cardboard frame.

2.6 [INERTIAL SEPARATOR FILTERS

A. Description: Inertial separators must be used to remove sand or blowing dust when environment at locale required in order to achieve required performance. Each air cleaner must consist of housing, bleed manifold, cell bodies, blade packs, bullnoses, and inlet screen.

B. Housing: Housings must be constructed of not less than 3.0 mm (11-gauge) [stainless] steel. The housing must be of all welded construction and equipment with continuous standing flanges around the periphery of both air entering and air exiting sides. Flanges must have pre-drilled bolt holes to facilitate field installation. The housing consists of one or more cells depending on airflow and resistance requirements.

C. Bleed Air Manifold: Housings must be equipped with a bleed air manifold constructed of not less than 3.0 mm (11-gauge) [stainless] steel, all welded construction. Manifold outlets must have a continuous standing flange with pre-drilled bolt holes to facilitate field connection. Manifolds must be sized to provide uniform airflow through each cell's dust bin for proper balance and dust removal.

D. Blade Packs: Blade packs must be constructed of not less than 0.91 mm (20-gauge) [stainless] steel with heli-arc welded construction. Blade pack vanes are to be individually formed and welded. Vanes must be arranged to provide a circuitous path to the airflow and redirect the air toward the clean air outlet. The air passageway between adjacent blades must have a minimum width of 4.83 mm. Blade packs must be removable to provide for inspection or service. Individual cells must include two removable blade packs and have a maximum center-to-center dimension of 127 mm and must be 610 mm in length.

E. Bullnose: The bullnose must be aerodynamically formed of 1.5 mm (16-gauge) [stainless] steel to provide proper air entry. One bullnose will be required for each two blade packs to

properly direct air to each tapered cell. Bullnose clamps must be constructed of 4.83 mm [stainless] steel and must be retained by 8 mm threaded stock welded to the center divider. The center divider must be constructed of 16-gauge [stainless] steel.

F. Bleed Slot: Bleed slots must be an integral part of each dust bin. The bleed slot/dust bin must be constructed of not less than 1.5 mm (16-gauge) [stainless] steel. The bleed slot must have a rounded entry configuration to minimize obstruction or plugging under heavy dust concentrations.

G. Inlet Screen: Inlet screens must consist of a 26-gauge, four-mesh, galvanized hardware cloth integrally supported by a double layered [1.5 mm (16-gauge) galvanized] [stainless] steel frame. Inlet screens must be bolted to the housing.

H. Finish: All finished components must be phosphatized and given a coat of zinc chromate primer and finished with a coat of grey enamel.

I. Efficiency: The air cleaner efficiency must not be less than 93 percent on Standardized Coarse Air Cleaner Test Dust, specific gravity of 2.54 and at 23.9 degrees C, at a clean airflow rate of 472 L/s per single cell using a bleed rate equaling 10 percent of inlet flow. Inlet to clean air outlet resistance must not exceed 290Paa at 472 L/s clean airflow.]

2.7 FACTORY QUALITY CONTROL

A. [Factory-Installed Test Ports: Manufacturer must provide factory-installed capped test ports in pre-filter access door. Place one in middle of each filter tier to facilitate field verification of aerosol uniformity during testing of air handling units with HEPA or HEGA filters.]

B. Test pre-filters in accordance with ASHRAE Standard 52.2.

C. Air Separator Filters: Test in accordance with general requirements outline in ISO 5011.

D. [HEPA Filters: Test in accordance with IEST RP-CC001.]

E. [HEGA Filters: Test in accordance with IEST-RP-CC008 for gas phase adsorber cells.]

F. [HEGA Test Canisters: When HEGA filters are used for air filtration, provide three accessible test canisters. Install test canisters in bypass line. Subject canisters to same airstream and approximate air flow (velocity and residence time) as primary HEGA filters. Install on AHU with bulk adsorption media filter sections.]

G. [HEPA and HEGA Filters: Test in accordance with applicable sections of both ASME N509 High Efficiency Air Cleaning Devices and ASME AG-1 Code on Nuclear Air and Gas Treatment. Minimum Testing Requirements:

1. Test filter section of AHU for filter alignment and fit, and for clamping mechanism operation.

2. Leak test sealing surfaces of filter section in accordance with ASME AG-1 before leaving factory. Record pressure readings once per minute for five minutes. Maximum leak rate must not exceed 0.0008 liters per second per cubic meter of filter housing volume.]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use construction filters during construction to protect air handling units and ductwork until all construction such as millwork, stone cutting, and painting are complete in each building.

B. Installation of any filters other than construction filters must not occur until all construction work/rework that may create dusty or volatile chemicals has ceased.

C. Clean the housing and ducts to remove all dust and particulates before installing activated carbon and HEPA filters.

D. Install filter frames according to manufacturer's written instructions.

E. Position each filter unit with clearance for normal service and maintenance.

F. Install filters in position to prevent passage of unfiltered air.

G. Filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter are factory installed. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

H. Coordinate filter installations with duct and air-handling unit installations.

I. Installation of air separator filters must be per manufacturer’s recommendations. Air separators will require material handling centrifugal fans with discharge piping to atmosphere.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory trained representative to inspect field-assembled components, filter and filter-frame installation, and electrical wiring. Report results in writing.

B. [Field-Installed Test Ports: Manufacturer must provide two test ports capable of being installed in field ductwork for sampling of airstream required during HEPA or HEGA filter testing. Test ports must be cast aluminum or zinc alloy, capable of being screwed in over neoprene gasket and sealed with removable cap.]

C. [HEGA Filter Systems: Install sampling canister assemblies in accordance with manufacturer's installation requirements.]

D. [HEPA and HEGA Filter Systems: Locate factory installed sampling and injection ports, and install upstream and downstream sampling ports required by filter manufacturer for testing filters.

1. Downstream readings must not exceed 0.1 percent of upstream HEGA filter gas adsorbent test gas concentration, or 0.03 percent of upstream HEPA value for test particles (e.g., DOP or PAO).]

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, wipe down filter housings and install new pre-filter media.

3.4 DEMONSTRATION

A. Manufacturer's field service representative must train post technicians on operation and maintenance of installed **[HEPA][and] [HEGA]** filters.

END OF SECTION 234105

SECTION 236422 - HEAT RECOVERY CHILLERS AND SIMULTANEOUS HEATING-COOLING CHILLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, electric-motor-driven heat recovery modular chillers.

B. This Section identifies standards for heat recovery chillers when these chillers are used as part of a Contractor-selected approach to conformance with energy efficiency requirements of the Chapter 13 of the OBO Building Code (International Building Code as amended by OBO).

C. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete” where concrete base is used.
2. Section 055005 “Metal Fabrications” where steel framing and supports are used.
3. Division 07 Section on roof accessories.
4. Section 230719 “HVAC Piping Insulation.”
5. Division 23 Section on refrigerant monitoring and safety equipment for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.
6. Section 260518 “Low Voltage Electrical Power Conductors and Cables” for connecting electrical and controls wiring.
7. Section 260525 “Grounding and Bonding for Electrical Systems” for grounding water chillers.
8. Section 260573 “Overcurrent Protective Device Coordination Study” for arc flash compliance and training.

1.2 DEFINITIONS

A. EER: Energy-Efficiency Ratio. Ratio of cooling capacity given in terms of Btu/h to total power input given in terms of watts at any given set of rating conditions.

1.3 SYSTEM PERFORMANCE REQUIRMENTS

A. Chiller Power Characteristics: Suitable for voltage and frequency supplied by the local utility or Post, as applicable.

1.4 NOTE: REFER TO OBO-ICS IMC CHAPTER 11 REFRIGERATION AND EDIT SECTION ACCORDINGLY.

A. Design chiller for parallel evaporator water flow.

B. The liquid to be heated/chilled will be water containing corrosion inhibitors or isolated by means of a double wall heat exchanger.

C. [Seismic Performance: Chillers shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."]

D. [Corrosion Resistance: Units installed in an outdoor location shall be covered or placed in a sheltered location as specified by the equipment manufacturer.]

E. Simultaneous Heating and Cooling Heat Pump: Provide a simultaneous heating and cooling heat pump with valves that allow each module to be operating in either heating, cooling, or simultaneous dedicated heat recovery mode.

1. This shall be accomplished by use of butterfly valves on headers to direct flow of water from heating, cooling and source sink loops which divert water to achieve all heating and cooling needs of a building without use of refrigerant side valves or inefficient co-current heat exchanger flow.
2. In cooling mode, chilled water is routed to chilled water header cooling loop, condenser water to hot water loop, and excess hot water from condenser water that a building does not need is routed to the sink.
3. In heating mode, chilled water loop has heat extracted from it and rejected back into a building where heating needs exist, and additional heating requirements are made up by extracting heat from source.
4. All control of modes of operation, valve positioning, staging of compressors, and safeties shall be provided by manufacturer of simultaneous heating and cooling heat pump.

1.5 SYSTEM DESCRIPTION

A. Heat Recovery Chiller shall consist of modules that each incorporate compressors in a refrigerant circuit; that circuit shall be constructed to be independent from other circuits from refrigeration and electrical standpoint.

1. Each refrigerant circuit shall consist of controls and dual compressors, including at least one variable speed compressor, feeding common condenser, evaporator, and thermal expansion valve.
2. Heat Recovery Chiller shall be able to produce hot water (i.e., 55 deg. C or higher condenser leaving water temperature) even in event of failure of one or more refrigerant circuits.
3. Circuits shall not contain more than 0.45 kg. (1 lb.) of refrigerant per nominal Ton of Refrigeration.

1.6 SUBMITTALS

A. Product Data: Include refrigerant type; oil type; rated capacities; power factor; shipping, installed, and operating weights; tagged locations of vibration/seismic supports; furnished specialties; and accessories for each model indicated. Performance data shall demonstrate conformance to simultaneous cooling and heating demand at scheduled summer/winter design conditions.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Drawings shall include plan and elevation views of equipment.

C. Design Calculations: Calculate requirements for selecting individual vibration isolators and seismic restraints.

D. Vibration**[/Seismic]** Isolation Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.

E. Wire Diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

F. Piping Diagrams detailing connections, including flushing bypass connection, between chiller and ancillary equipment and differentiating between manufacturer-installed and field-installed piping and accessories.

G. Coordination Drawings: Floor plans drawn to scale and coordinating the following, as appropriate:

1. Structural Supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements. Determine spaces reserved for electrical equipment.
4. Access requirements around other work, including working clearances to mechanical controls and electrical equipment, and any building obstructions that may reduce airflow to condenser coils.

H. Product Certificates: Certifications required in Part 1 Article on QUALITY ASSURANCE, as well as certification that chillers have been factory-started and function properly.

I. Source quality-control test reports as required in the Part 2 Article on SOURCE QUALITY CONTROL. Include copy in Operating and Maintenance Manual. Submit an extra copy for Post Facility Manager.

J. Field Report: Performance testing as required in Part 3 Article on START-UP SERVICE. Include copy in Operating and Maintenance Manual. Submit an extra copy for Post Facility Manager.

K. Operating and Maintenance Manuals: Include operating and maintenance manuals for the chiller and pump/heat exchanger/control package. Include information regarding availability of spare parts in the country where this unit is to be deployed.

L. Written Government Acceptance.

1.7 QUALITY ASSURANCE

A. Capacity Rating Certification: Signed by manufacturer certifying chiller design has been tested and rated using calibrated instrumentation in accordance with methods described in AHRI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle," for water-cooled chillers.

B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15, “Safety Code for Mechanical Refrigeration.” Comply with ANSI/ASHRAE Guideline 147, “Reducing Release of Halogenated Refrigerants from Refrigeration and Air-Conditioning Equipment and Systems” for refrigerant leaks, recovery, and handling and storage requirements.

C. Comply with requirements of the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

D. Comply with UL 1995 “Heating and Cooling Equipment.”

E. Government Acceptance: After A/E of Record has reviewed and approved chiller submittals, contractor shall obtain mandatory written acceptance of chiller submittals from Project Director/COR based on input from OBO/PDCS/DE mechanical engineer assigned to project prior to procurement of each chiller.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory with modules wired and fully charged with refrigerant or nitrogen. If shipped with nitrogen, provide refrigerant canisters capable of providing full operating charge of refrigerant and oil for all modules.

1.9 COORDINATION

A. Contractor shall coordinate size and location of concrete pads with suitable adjacent maintenance area. Cast anchor-bolt inserts into pads. Concrete, reinforcement, and formwork requirements are specified in Section 033000 “Cast-in-Place Concrete.”

B. If roof installation is approved by OBO DE/ME engineer, Contractor shall coordinate installation of roof curbs/structural platforms and roof penetrations. For concrete, reinforcement, and formwork requirements refer to Section 033000 “Cast-in-Place Concrete.” For structural platforms requirements, refer to Section 055005 “Metal Fabrications.” For roof penetration assembly, refer to Division 07 Section on roof accessories.

1.10 WARRANTY

A. Refrigeration Compressor Warranty: Manufacturer's standard form signed by the manufacturer in which manufacturer agrees to repair or replace compressors that fail in materials or workmanship within specified warranty period.

1. Failure includes, but is not limited to, inability to maintain set temperature.
2. Compressor Warranty Period: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials identified below. Package extra materials with protective covering for storage and identification labels describing contents.

1. One control circuit board of each type.
2. Power phase monitor.

PART 2 - PRODUCTS

2.1 HEAT RECOVERY CHILLER MODULES

A. Available manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

1. Multistack LLC: Multistack Dedicated Heat Recovery Chiller.
2. Arctichill.

B. Description: Heat Recovery Chiller shall consist of modules that each have controls and an independent refrigerant circuit that incorporates dual rotary scroll type compressors, condenser and evaporator heat exchangers, and electronic expansion valve. Multi-circuit chiller shall be able to produce chilled water and condenser water even in event of failure in one or more refrigerant circuits.

C. Cabinet: Provide lifting base, structural frame, and housing (weatherproof if scheduled to be mounted outdoors) in accordance with Table 2.1, “Heat Recovery Chiller Requirements – Building Cooling Application.”. Coat the base, frame, and housing with a corrosion resistant coating capable of withstanding a 1000-hour salt spray test according to ASTM B 117 with a minimum ASTM 1654 rating of “6.” If base and frame are constructed of stainless or hot dip galvanized steel, then coating is not required unless noted elsewhere. Refer to Table 2.1, for inland and marine module construction requirements.

D. The Heat Recovery Chiller Modules shall be ETL listed in accordance with UL Standard 1995 and CSA certified per Standard C22.2#119, and bear ASME UM stamp on all heat exchangers.

E. [Where site conditions require it, modules shall be capable of being hoisted in elevator having 1200 kg capacity and, where site specific conditions require it, be able to fit through 0.75 x 2.0 meter door set.]

F. Provide chiller array with single point power connection. This shall include pre-engineered wiring for field installation and connection to factory mounted chiller junction box. Electrical junction box shall incorporate a through-the-door disconnect with over-current protection. Junction box shall include individual circuit breakers for each Module Set a maintenance outlet and at least one spare, and shall provide a single point of connection to building power.

TABLE 2.1
HEAT RECOVERY CHILLER REQUIREMENTS –
BUILDING COOLING APPLICATION

COMPONENTS	INLAND LOCATION AND/OR INDOOR INSTALLTION	MARINE LOCATION WITH OUTDOOR INSTALLATION
Module Configuration	N+0 (Maintain minimum scheduled building cooling/heating load)	N+0 (Maintain minimum scheduled building cooling/heating load)
Manifolds	Stainless steel inlet and inline strainer	Stainless steel inlet and inline strainer
Pumps	Cast iron housing; bronze impeller; variable frequency drive (where required by chilled water system design)	Stainless steel housing; bronze impeller; variable frequency drive (where required by chilled water system design)
Valves	Standard shut-off servicing valves on heat exchangers	Stainless shut-off servicing valves on heat exchangers
Housing	Galvanized steel or aluminum	Galvanized steel w/ factory-applied powder coat epoxy finish
Structural Frame	Powder-coated structural steel	Galvanized steel w/ factory-applied powder coat epoxy finish
Lifting Base	Painted structural steel	Hot dip galvanized steel
Control Panel	On chiller	On chiller

G. Note to Table 2.1:

1. Hot-dipped galvanized members shall have all penetrations made before the galvanization is done to minimize early rusting. Minimum coating thickness shall be 70 micrometers (1.60 oz. of zinc per sq. ft.).

2. Review project-specific requirements to address corrosion resistance for outdoor installations. Refer to the Part 1 Article on SYSTEM PERFORMANCE REQUIREMENTS.

2.2 CHILLED AND HOT WATER MAINS

A. Each module shall include supply and return mains for both chilled and hot water. Provide factory installed pressure taps on supply and return water pipes and drain line with 20-mm valve on each water system. Grooved end connections shall be provided for interconnection to DN 150 standard piping with grooved pipe type couplings.

B. Strainer: Each inlet water header shall incorporate built-in removable 30-mesh in-line strainer system to prevent heat exchanger fouling. Construct each strainer of Teflon coated stainless steel mesh with stainless steel supports, with minimum surface area of 0.37 square meters.

2.3 EVAPORATORS AND CONDENSERS

A. Each evaporator and condenser shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with ASME code for 3030 kPa working pressure for refrigerant R-407C and 4500 kPa working pressure for refrigerant R-410A. Mount both condenser and evaporator heat exchanger below compressor to eliminate effect of migration of refrigerant to cold evaporator with consequent liquid slugging on start-up.

2.4 REFRIGERANT

A. Refrigerant must be one of the fluorocarbon gases with number designation and safety classification in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0. Provide Safety Data Sheets (SDS) for all refrigerants. Refer to US EPA Significant New Alternatives Policy (SNAP) for more information.

2.5 COMPRESSOR

A. Each module shall contain two hermetic scroll compressors independently circuited and with internal spring isolation mounted to module with rubber-in-shear isolators. Each system shall include high discharge pressure and low suction pressure manual reset safety cut-outs. Refrigerant circuit charging point shall be on suction side of compressor. Provide acoustical wrap on each compressor.

2.6 INSULATION

A. Hot and Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation with thermal conductivity of 0.26k (BTU/HR-FT2-°F]/in.) maximum. Insulation shall conform to

ASTM C 534, Type II, for sheet materials. See tables in Section 230719 "HVAC Piping Insulation."

1. Thickness: 19mm minimum.
2. Adhesive: Provide adhesive recommended by insulation manufacturer.
3. Insulation: Provide Factory applied insulation over entire surfaces of water chiller components.

    a. Apply adhesive to 100 percent of insulation contact surface.
    b. Seal seams and joints.

2.7 CENTRAL CONTROL SYSTEM

A. Equip Heat Recovery Chiller with microprocessor-based return water controller. Heat Recovery Chiller shall have capability to operate in response to either entering heating water or cooling water set points. Selection of these two modes of operation shall be made automatically by Heat Recovery Chiller's Master Controller or alternatively, this mode may be set manually or through binary BAS input to controller.

B. Scheduling of the various compressors shall be performed by microprocessor based control system (Master Controller). A new lead compressor shall be selected every 24 hours to assure even distribution of compressor run time. Load limit control shall be available to limit number of compressors that can be energized at one time.

C. The Master Controller shall monitor and report the following on each refrigeration system:

1. Discharge Pressure Fault.
2. Suction Pressure Fault.
3. Compressor Winding High Temperature Fault.
4. Suction Temperature.
5. Evaporator Leaving Chilled Water Temperature Fault.

D. The Master Controller shall monitor and report the following system parameters:

1. Chilled Water Entering and Leaving Temperature.
2. Hot Water Entering and Leaving Temperature.
3. Chilled Water and Hot Water Flow Status.

E. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor circuit. In the case of a System Fault the entire Heat Recovery Chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's LCD display. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).

F. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.

G. The control system shall monitor entering and leaving hot and/or chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to fine tune the Heat Recovery Chiller to different existing building conditions.

H. Interlock condenser water (heating load) pump with Master Controller on chiller, with chiller locked out until condenser water pump is verified "ON." Chilled water pump shall indicate chilled water pump load before chiller will be enabled. If entering heating water temperature exceeds safe limit, Master Controller shall lock out condenser water pump and initiate system alarm at Master Controller

2.8 BUILDING AUTOMATION SYSTEM (BAS) CONNECTION

A. Heat Recovery Chiller shall have factory-installed control panel with hardware and software, and with auxiliary contact to enable building management system to monitor and control set points and chiller control displays and alarms. Inputs/Outputs shall include:

1. Remote Start/Stop.
2. Heating/Cooling Alarm.
3. Run time accumulator.
4. Chiller Run Status Relay.
5. Chiller Failure Alarm (enacted when a preset number of compressors fail).
6. Condenser Water and Chilled Water Flow Switches.
7. Condenser and Chilled Water Entering and Leaving Water Temperatures.

B. Provide communication interface building automation system using BACNET or matching BAS protocol, which shall enable building automation system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system

2.9 SAFETIES, CONTROLS, AND OPERATIONS

A. Provide safety controls system for Heat Recovery Chiller unit as follows:

1. Low Evaporator Refrigerant Pressure.
2. Loss of Flow thru the Evaporator or Condenser.
3. High Condenser Refrigerant Pressure.
4. High Compressor Motor Temperature.
5. Low Leaving Evaporator Water Temperature.

B. Failure of Heat Recovery Chiller to start or of Heat Recovery Chiller to shutdown due to any safety cutouts shall initiate an alarm at BAS front end, and failure shall be enunciated by display

of the appropriate diagnostic description at the unit control panel. This annunciation shall be in plain English. Alphanumeric codes shall be unacceptable.

C. The Heat Recovery Chiller shall be furnished with a Master Controller as an integral portion of the Heat Recovery Chiller control circuitry to provide the following functions:

1. Provide automatic Heat Recovery Chiller shutdown during periods when the load level decreases below the normal operating requirements of the Heat Recovery Chiller. Upon an increase in load, the Heat Recovery Chiller shall automatically restart. For loads between minimum and maximum capacity, chiller shall stop and start compressors to track load.
2. Provisions for connection to automatically enable the Heat Recovery Chiller from on-site energy management system.
3. The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English/Metric (selectable) units.

D. Normal Heat Recovery Chiller Operation:

1. When Heat Recovery Chiller is enabled, the factory supplied Master Controller modulates the Heat Recovery Chiller capacity from minimum to maximum as required by the simultaneous water and condenser (hot) water loads.
2. The Heat Recovery Chiller control system shall simultaneously respond to either Leaving (variable flow systems) or Entering (constant flow systems) Condenser (Hot) and Chilled Water Temperatures and will have an integral reset based on each entering or leaving water temperature to provide for efficient operation of compressors at part-load conditions.
3. **[Variable Flow Operation – Chilled and/or Condenser Water: Butterfly type isolation valves shall incorporate appropriate accessories and controls to allow the chiller to operate efficiently. Valves shall modulate via a motorized actuator for leaving water temperature control, chiller minimum flow bypass, chiller no load bypass, or head pressure control.]**

E. Power Phase Monitor: Provide Power Phase Monitor on incoming power supply to Heat Recovery Chiller; Basis of Design, SymCom. This device shall prevent Heat Recovery Chiller from operating during periods when incoming power is unsuitable for proper operation. The Power Phase Monitor shall provide protection against the following conditions:

1. Over and Under Voltage (Brown-Out).
2. Phase Rotation.
3. Loss of Phase.
4. Phase Imbalance.

2.10 ACCESSORIES

A. [Vented Hot Water Heat Exchanger for Potable Water: Hot water heat exchanger shall be double wall vented and certified for use with domestic water.]

B. Power Factor Correction: Provide power factor correction with chiller to meet or exceed a power factor of 0.95 unless contractor certifies that power factor correction shall be provided at the site level to ensure site power factor does not fall below 0.95.

C. Special Tools Kit: Chiller manufacturer shall assemble tool kit specially designed for use in serving the chiller(s) furnished that contains any special tools required to service chiller components not readily available to Government service personnel in performing routine maintenance. Place tools in lockable case with hinged cover. Provide list of each tool furnished and affix list to underside of case cover.

2.11 SOURCE QUALITY CONTROL

A. Factory test fully assembled heat recover chillers before shipping, according to a written protocol. Provide test report indicating test instrumentation, test conditions, acceptable limits for test results, and results. Testing shall, at a minimum, include the following tests performed at the voltage and frequency for the country of installation. Test instrumentation shall be selected and calibrated, and measurements made, in accordance with the "Instrumentation" Section of Appendix C of AHRI Standard 550/590.

1. Perform system measurements of entering and leaving water temperatures, flow rate, and power input. Calculate total system cooling capacity and efficiency in kW/ton and heating capacity and efficiency in Coefficient of Performance (COP).
2. Demonstrate specified compressor phasing in response to increasing and decreasing load conditions.
3. For each compressor module, record compressor RLA, discharge pressure, suction pressure.
4. Demonstrate system protection and auto-restart after the following conditions:

    a. Phase loss.
    b. Power failure.
    c. Flow loss.
    d. Over voltage.
    e. Under voltage.

5. Demonstrate system protection in case of high head pressure.

B. Facilitate witness by OBO/PDCS/DE/ME representative of source quality-control tests described above; notify Project Director/COR of testing date and location 14 days in advance. Provide written protocol to be used for testing at notification.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Final water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

A. Install water chillers plumb and level on concrete housekeeping pad, or if roof mounted, on roof concrete pad or structural frame. Concrete base is specified in Division 23 Section, and concrete materials and installation requirements are specified in Section “Cast-in-Place Concrete.”

B. [Anchor chiller mounting frame to concrete base.

1. For supported equipment, install stainless steel anchor bolts that extend through concrete base and anchor into structural slab.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.]

C. [Structural Roof Frame: Anchor chilled mounting frame to the structural frame.

1.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be anchored.]

D. Vibration Isolation: Vibration isolation devices and installation requirements shall conform to requirements of the OBO Building Code. See Division 23 Section on vibration and seismic controls for HVAC piping and equipment for additional requirements.

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Verify satisfactory refrigerant charge in accordance with manufacturer service manual.

G. Install separate devices furnished by manufacturer.

3.3 CONNECTIONS

A. Chilled-water, condenser (hot)-water, and heat exchanger piping installation requirements are specified in Division 23 Section on hydronic piping. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install and route piping adjacent to chiller to allow service and maintenance.

C. Install unit connections to both chilled water and condenser (hot) water piping using flanged shut off valves to allow chiller isolation from each system independently for maintenance.

D. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer, strainer, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, flow switch, flow meter, balancing valve, thermometer, pressure gage, and union or flange.

E. Condenser Connections: Connect inlet to condenser with shutoff valve, thermometer, plugged tee, and pressure gage. Connect outlet to condenser with shutoff valve, thermometer, drain line and shutoff valve, flow switch, flow meter, strainer, and plugged tee.

F. Refrigerant Pressure Relief Valve Connections: For indoor units, extend vent piping to outside without valves or restrictions when ASHRAE 15 requirements dictate

G. Ground water chillers in accordance with Chapter 2 of the OBO Electrical Code. Refer to Section 260525 “Grounding and Bonding for Electrical Systems.”

H. Connect wiring according to Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 PIPE SYSTEM FLUSHING PROCEDURE

A. Prior to connecting Heat Recovery Chiller to condenser and chilled water loop, flush piping loops with detergent and hot water 43-55 deg. C (110-130 deg. F) mixture to remove previously accumulated dirt and other organic. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.

B. During flushing, 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in system piping and examined periodically as necessary to remove collected residue. Flushing process shall take no less than 6 hours or until the strainers when examined after each flushing are clean. Old systems with heavy encrustation shall be flushed for minimum of 24 hours, and may take as long as 48 hours before the filters run clean. Use detergent and acid concentrations in strict accordance with respective chemical manufacturers instructions. After flushing with detergent and/or dilute

acid concentrations, purge system loop with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

C. Prior to supplying water to Heat Recovery Chiller, coordinate with Section 223230 "Potable Water Treatment" requirements regarding water quality during Heat Recovery Chiller operation. Appropriate Heat Recovery Chiller manufacturer's service literature shall be available to operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

3.5 WATER TREATMENT

A. Supply water for both hilled water and heating hot water (i.e. non-potable hot water) circuits shall be analyzed and treated by professional water treatment specialist who is familiar with operating conditions and materials of construction specified for the Heat Recovery Chiller's heat exchangers, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for modular Heat Recovery Chillers using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within parameters identified in Table 3.5, "Water Treatment Parameter":

TABLE 3.5
WATER TREATMENT PARAMETERS

FACTOR	PARAMETER
pH	Greater than 7 and less than 9
Total Dissolved Solids (TDS)	Less than 1000 ppm
Hardness as $CaCO_3$	30 to 500 ppm
Alkalinity as Ca CO_3	30 to 500 ppm
Chlorides	Less than 200 ppm
Sulfates	Less than 200 ppm

3.6 START-UP SERVICE

A. Engage a technician, factory-trained on equipment being installed, to inspect field-assembled components and equipment installation, including piping and electrical connections, and to perform testing and start-up service.

1. To facilitate OBO/PDCS/DE/ME representative witness of testing and start-up service, notify Project Director/COR of testing date and location 14 days in advance.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and chiller refrigerant circuits have been leak tested.
2. Verify that pumps are installed and functional. Verify proper motor rotation.
3. Verify that chiller properly starts and stops based on system demands, testing both chilled water and heating water as starting variables.
4. Verify that thermometers and gages are installed.
5. Clean factory installed header strainers. Verify that piping systems have been flushed and system strainers cleaned. Verify water treatment added.
6. Operate water chiller for run-in period according to manufacturer's written instructions.
7. Check bearing lubrication and oil levels.
8. Verify that refrigerant pressure relief is vented outside on indoor-mounted units.
9. Verify installation and freedom of movement of vibration isolators and seismic anchors, if required for site, including deflection during water chiller startup and shutdown.
10. Verify and record performance of chilled- and condenser (hot)-water flow and low and high-temperature interlocks.
11. Verify and record performance of water chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

C. Field Report: Prepare written startup report that records results of tests and inspections. Provide copy of test report to Project Director/COR before routine operation of equipment during construction.

3.7 OCCUPANCY ADJUSTMENTS

A. Occupancy Adjustments: At times requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.8 DEMONSTRATION AND TRAINING

A. Factory-trained technician shall demonstrate and train Government’s maintenance personnel. Provide minimum of two sets of training sessions, recorded for future reference, with each set of session held at a distinctly different time period to accommodate personnel identified by Project Director/COR based on input from Post’s Facility Manager. Each set of sessions shall include 4 hours in classroom and 4 hours of demonstration. Schedule one additional training session during the occupancy adjustment visit to allow post personnel to address operating challenges.

1. Training topics shall include adjusting, operating, and maintaining chillers. Include procedures and schedules related to start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming for maintaining water chillers in coordination with the complete chilled-water system, instrumentation and control system. Review of control drawings and schematics, data in maintenance manuals, and interactions with other systems.

2. Refer to the Part 3 Article on ARC FLASH TRAINING in Section 260573 “Overcurrent Protective Device Coordination Study” for associated training requirements.

END OF SECTION 236422

SECTION 236427 - AIR-COOLED, ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, electrical-motor-driven, air-cooled, rotary-screw water chillers.

B. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete” where concrete base is used.
2. Section 055005 “Metal Fabrications” where steel framing and supports are used.
3. Division 07 series on Roof Accessories.
4. Division 23 Section on Common Motor Requirements for HVAC Equipment.
5. Division 23 Section on Sleeves and Sleeve Seals for HVAC Piping.
6. Division 23 Section on Meters and Gages for HVAC Piping.
7. Division 23 Section on General-Duty Valves for HVAC Piping.
8. Division 23 Section on Vibration and Seismic Controls for HVAC.
9. Division 23 Section on Identification for HVAC Piping and Equipment.
10. Section 230719 “HVAC Piping Insulation.”
11. Section 230905 “Instrumentation and Controls for HVAC.”
12. Section 260508 “Common Work Results for Electrical, Communications and Electronic Safety.”
13. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
14. Section 260525 “Grounding and Bonding for Electrical Systems.”
15. Section 260915 “Electrical Power Monitoring.”

1.2 DEFINITIONS

A. BAS: Building Automation System.

B. BPVC: Boiler Pressure and Vessel Code.

C. COP: Coefficient of Performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

D. EER: Energy-Efficiency Ratio. Ratio of cooling capacity given in terms of Btu/h to total power input given in terms of watts at any given set of rating conditions.

E. IPLV: Integrated part-load value. Single-number part-load efficiency figure of merit calculated per method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

F. NPLV: Nonstandard part-load value. Single-number part-load efficiency figure of merit calculated per method defined by AHRI 550/590 and intended for operation other than AHRI standard rating conditions.

G. TEAO: Totally Enclosed Air Over.

H. TEFC: Totally Enclosed Fan Cooled.

I. TENV: Totally Enclosed Non-Ventilating.

1.3 SUBMITTALS

A. Product Data: Include refrigerant type with Safety Data Sheet; rated capacities; power factor; weights (shipping, installed, and operating); furnished specialties; verification of dimensions; accessories for each model indicated; and tagged locations of vibration/seismic supports. Performance data shall demonstrate conformance to AHRI standard conditions and at site conditions indicated on drawings as well as AHRI standard unloading conditions.

B. Product Certificates:

1. AHRI Certification of Product Ratings certifying that chiller has been tested and rated using calibrated instrumentation in accordance with AHRI 550/590 certification program.
2. ASHRAE Certification signed by manufacturer certifying compliance with ASHRAE 15, “Safety Code for Mechanical Refrigeration.”
3. ASME Form U-1 Manufacturer’s Data Report for Pressure Vessels as required by the provisions of the ASME BPVC Rules, Section VIII, Division 1.

C. Shop Drawings: Drawings shall be signed and sealed by qualified professional engineer and shall include both plan and elevation views of equipment. Include the following:

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Vibration Isolation Base and Seismic Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights, and auxiliary motor slides and rails.
3. Wiring Diagrams: Detail wiring for power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring.
4. Piping Diagrams: Detail connections between chiller and ancillary equipment. Differentiate between manufacturer-installed and field-installed piping and accessories.

D. Coordination Drawings: Floor plans, elevations, and sections drawn to scale that coordinate:

1. Size and location of structural platforms/supports and/or concrete bases with cast anchor-bolt inserts.
2. Roof curbs and roof penetrations.
3. Columns and beams.
4. Piping roughing-in requirements.
5. Wiring roughing-in requirements. Determine spaces reserved for electrical equipment.
6. Access requirements to include working clearances to mechanical controls and electrical equipment.

E. Operating and Maintenance Manuals: Include operating and maintenance manuals for chiller and associated equipment/accessories.

F. Source quality-control test reports as required in the Part 2 Article on SOURCE QUALITY CONTROL. Include copy in Operating and Maintenance Manual.

G. Field Report: Performance testing as required in the Part 3 Article on STARTUP SERVICE. Include copy in Operating and Maintenance Manual.

1.4 QUALITY ASSURANCE

A. UL: Comply with UL 465 "Safety Central Cooling Air Conditioners" and standard UL 1995 "Heating and Cooling Equipment."

B. OBO Electrical Code: Comply with OBO Electrical Code (NFPA 70, National Electrical Code as amended by OBO). Note that electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70 (as amended by OBO), Article 100, by a testing agency acceptable to authorities having jurisdiction.

C. ASHRAE: Comply with ANSI/ASHRAE 147 Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.

D. Government Acceptance: After A/E of Record has reviewed and approved chiller submittals, contractor shall obtain mandatory written acceptance of chiller submittals from Project Director/COR (based on input from OBO/PDCS/DE mechanical engineer assigned to project) prior to procurement of each chiller.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Transport chillers from the factory fully charged with **[refrigerant and oil][nitrogen to protect against refrigerant leaks during transport and ship oil in container separate from chiller]**. Maintain protective crating and covering to protect chillers. The unit will be covered at the factory with a PVC coated polyester tarp that is tied to the chiller base to help protect the chiller from weather and debris during shipment especially in the winter months and on shipping vessels.

B. Handle chillers according to manufacturer's written rigging and installation instructions for unloading, transporting, and setting in final location.

C. Store chillers to prevent damage. Store chillers in clean dry space to protect from weather, humidity and temperature variations, dirt and dust, fumes, water, and construction debris. Note that protection from 'weather' includes wind-driven elements such as sand and salt.

D. Any materials found damaged must be replaced at Contractor's expense.

1.6 WARRANTY

A. Refrigeration Compressor: Manufacturer's standard form in which manufacturer agrees to repair or replace compressors that fail in materials or workmanship within specified period.

1. Failure includes but is not limited to inability to maintain set temperature.
2. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials identified below. Package extra materials with protective covering for storage and identification labels describing contents.

1. Power phase monitor.
2. One complete set of oil filters and water filters as applicable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carrier Global Corporation.
2. Daikin Applied.
3. Trane Technologies.
4. York; a Johnson Controls company.

2.2 SYSTEM DESCRIPTION

A. Packaged assembly, factory-assembled, and factory-tested air-cooled, rotary-screw chiller including lifting base, mounting frame, casing, compressor (to include lubrication system), heat exchanger, condenser coils, condenser fans, integrated controls, interconnected piping, interconnected wiring, indicated accessories, and motors.

2.3 PERFORMANCE REQUIREMENTS

A. Efficiency: Chiller Full-Load Efficiency and IPLV shall meet or exceed those required by ASHRAE 90.1 for air-cooled chillers.

B. Seismic Performance: Chillers shall withstand effects of earthquake motions determined according to ASCE/SEI 7. **[Designer of Record shall insert seismic risk category requirement for project location.]**

1. Term "withstand" means "unit will remain in place without separation of any parts from device when subjected to seismic forces specified, and unit will be fully operational after seismic event."
2. Vibration isolation integral to the equipment shall be designed/selected by chiller manufacturer to meet Project seismic criteria.

C. Wind Load Rating: Unit shall be tested and rated to withstand wind speeds up to maximum design criteria for project location. **[Designer of Record shall insert wind speed requirement for project location.]** Provide engineer-stamped certificate that equipment has been evaluated and built to meet the required wind velocity.

D. Site Altitude: Chiller shall be suitable for altitude in which installed without affecting performance indicated. Adjust affected chiller components to account for site altitude of **[Designer of Record shall insert altitude requirement for project location]**.

E. Noise Rating: Provide sound power level measured according to ANSI/AHRI 370 “Sound Performance Rating of Large Air-cooled Outdoor Refrigerating and Air-conditioning Equipment.” Isolate vibrating, reciprocating, and rotating equipment mounted to roof or building structure from its associated piping and ducting and from building structure.

F. Outdoor Operating Conditions:

1. High Temperature: Unit shall have high-ambient operating capability up to **[51][XX]** deg C.
2. Low Temperature: Provide low-ambient controls for operation down to **[-15][XX]** deg C. If propylene glycol mixture is used to prevent freezing, equipment shall be sized to allow for derated capacities. Ethylene glycol and heat trace shall not be used to meet this requirement.

G. Corrosion Resistance: Chiller shall be suitable for outdoor installation indicated and capable of withstanding ASTM B117 salt spray test based on the level of corrosion risk as identified for the site in OBO IBC Appendix W. For this contract, follow the requirements for **[Low/Moderate][Extreme]** Risk.

1. Low/Moderate Risk:

   a. Base, frame, and casing: 1,000 hours
   b. Coils: 1,000 hours

2. Extreme Risk:

   a. Base, frame, and casing: 10,000 hours
   b. Coils: 5,000 hours

H. Power Factor Correction: Provide power factor correction (either at chiller level or site level) to maintain or exceed power factor of 0.95. (Note: this is often provided via VFD but corrective capacitors are equally acceptable.)

I. Automatic Restart: After power interruption, equipment and associated controls will automatically return to operating state without need for manual intervention.

2.4 REFRIGERANT

A. Refrigerant: Refrigerant must be one of the fluorocarbon gases with number designation and safety classification in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0. Provide Safety Data Sheets (SDS) for all refrigerants. Refer to US EPA Significant New Alternatives Policy (SNAP) for more information.

B. Refrigerant circuits: Two or more independent refrigerant circuits.

C. [Refrigerant Detector and Alarm. This is only required for evaporators mounted remote from chiller. Detector must be the continuously-operating, halogen-specific type, appropriate for the refrigerant in use. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant(s) in use. The detector's relay must be capable of initiating corresponding alarms and ventilation systems as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation. Detector must be compatible with the facility's building management system.]

2.5 EVAPORATOR

A. Either brazed-plate or shell-and-tube configuration.

1. Shell and Tube:

a. Designed, inspected, and stamped in accordance with ASME BPVC Section VIII requirements.
b. Shell Material: Rolled carbon-steel plate with welded seams.
c. Shell Heads: Removable carbon-steel heads located at each end of tube bundle.
d. Tubes: Copper.

2. Brazed Plate:

a. Designed, inspected, and stamped in accordance with ASME BPVC Section VIII requirements.
b. Direct expansion, brazed-plate.
c. Type 304 or 316 stainless steel.

2.6 CONDENSER (AIR-COOLED)

A. Coils: Copper fins bonded to seamless copper tubing. In areas subject to acid rain as approved by OBO/PDCS/DE Mechanical Engineer, provide epoxy-coated aluminum fins. See Corrosion Resistance under Article on "Performance Requirements."

B. Fans: Direct-drive propeller type, statically and dynamically balanced, with vertical air discharge for high efficiency and low sound.

C. Fan Guards: Removable steel safety guards with corrosion-resistant coating.

D. Fan Motor: TEAO or TENV with bearings permanently lubricated and having built-in current- and thermal-overload protection. Maximum 960 RPM at 60 Hz or 800 RPM at 50 Hz. High efficiency, Class F insulation, 3-phase.

E. Sound Package: Provide factory weatherproof acoustically-lined compressor enclosure.

F. Coil Protection: Provide louvers to protect coils.

G. Compressor Protection: Provide either security bars or louvers to protect compressors.

2.7 COMPRESSORS

A. Positive displacement, direct drive, oil-lubricated, rotary screw type. The compressor housing shall be of cast iron. The rotor shall be manufactured from forged steel. The compressor shall incorporate a complete anti-friction bearing design.

1. Capacity Control: Fully modulating control from 100 percent to 20 percent of full load.
2. Lubrication System:

   a. Oil delivered by positive system pressure differential.
   b. Dual oil filter.
   c. Immersion oil heater.
   d. Sight glass.
   e. Strainer.
   f. Magnetic plug or removable magnet in sump.
   g. Factory-piped, refrigerant-cooled oil cooler.
   h. Oil separator designed, tested, and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

3. Compressor Motor:

   a. Type: TEAO or TEFC.
   b. Maximum operating speed: 3000 RPM at 50 Hz or 3600 RPM at 60 Hz.
   c. Mounting: D-flange, bolted to cast iron adaptor mounted on the compressor.

4. Vibration Isolation: Mount individual compressors on either of the following:

a. Seismic restrained-spring isolators with minimum deflection of 25 mm
b. Manufacturer recommended neoprene isolators.

2.8 INSULATION

A. Closed-cell, flexible elastomeric, ASTM C 534, Type I or II, thickness 38 mm.

2.9 PRESSURE RELIEF

A. Frangible-carbon rupture disc or single or multiple, reseating-type, spring-loaded relief valves. Routing and size of pressure-relief pipe shall be per ASHRAE 15.

2.10 ADDITIONAL ACCESSORIES

A. Provide low-ambient head pressure kit; factory-mounted and factory-wired chilled water flow switch; and individual compressor suction and discharge pressure gauges with shutoff valves for each refrigerant circuit.

2.11 ELECTRICAL

A. Wiring: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field-power connection to chiller. Wiring shall be numbered and color-coded to match wiring diagram. Factory wiring outside of an enclosure shall be in NFPA 70 compliant raceway.

B. Control Enclosure: House in a unit-mounted, NEMA 250, Type **[3R][4X]** enclosure with hinged access door with lock/padlock and key.

C. Main Disconnect: Field-power interface shall be to **[wire lugs][NEMA BS 31047, heavy-duty, non-fused disconnect switch][UL 489, instantaneous-trip circuit breaker with lockable handle]**. Disconnect means shall be interlocked with door operation.

D. Branch Disconnect: Provide branch power circuit to each motor and to controls with one of the following disconnecting means:

1. NEMA BS 31047, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection per IEC 60947-4-1.
2. NEMA BS 31047, heavy-duty, non-fusible switch.
3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

E. Overcurrent Protection: Provide each motor with overcurrent protection.

F. Overload Protection: Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.

G. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.

H. Service Receptacle: **[220][XXX]** Volt duplex GFCI receptacle rated for outdoors, powered separately.

I. Control Relays: Auxiliary and adjustable time-delay relays or integral to water chiller microprocessor.

J. Power Readings: Indicate the following for chiller electrical power supply:

1. Current, phase to phase, for all three phases.
2. Voltage, phase to phase, and phase to neutral for all three phases.
3. Three-phase real power (kilowatts).
4. Three-phase reactive power (kilovolt amperes reactive).
5. Power factor.
6. Running log of total power versus time (kilowatt-hours).
7. Fault log, with time and date of each.

K. Power Phase Monitor: Provide Power Phase Monitor on incoming power supply to chiller to prevent chiller from operating during periods when incoming power is unsuitable for proper operation. Power Phase Monitor shall protect chiller against following conditions:

1. Over and under voltage (brown-out)
2. Phase rotation
3. Loss of phase
4. Phase imbalance

2.12 CONTROLS

A. Manufacturer's standard microprocessor-based chiller controls; unit mounted, and factory-wired with a single-point power connection and separate control circuit.

B. Status Display:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Chilled water entering and leaving temperatures.
5. Refrigerant pressure in evaporator and condenser.
6. Saturation temperature in evaporator and condenser.
7. Temperature and pressure of operating setpoints.
8. No cooling load condition.
9. Outside air temperature if required for chilled-water reset.
10. Oil temperature and pressure.
11. Current-limit setpoint
12. Number of compressor starts.
13. Percent of motor maximum amperage.
14. Alarm history with retention of operational data before unit shutdown.

C. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Leaving- and entering-chilled-water temperatures, control setpoints, and motor load limit.
3. Current limit and demand limit.
4. External chiller emergency stop.
5. Automatic lead/lag switching.
6. Provide contacts for hardwiring of enable/disable, chiller status, and general alarm points.
7. Provide phase loss/reversal protection and over/under voltage protection with chiller auto-restart capability when voltage levels are restored to acceptable range.
8. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
9. **[Control logic and factory-installed sensors to reset leaving chilled water temperature setpoint based on [return water temperature][outdoor air temperature][space temperature].]**

D. BAS Interface: Factory-installed hardware and software to enable BAS to monitor, display, and control chiller control points and alarms. All chiller control points shall be available via ASHRAE 135 BACnet protocol for BAS integration. Also, see Section 230905 "Instrumentation and Controls for HVAC" for chiller control points that are required to be hardwired to a controller on the BAS.

2.13 SOURCE QUALITY CONTROL (OBO-WITNESSED FACTORY TEST)

A. Verification of Performance: Prior to shipping, factory test fully assembled air-cooled chillers according to a written protocol. Provide test report indicating test instrumentation, test conditions, acceptable limits for test results, and results. Test instrumentation shall be selected, calibrated, and used in accordance with the "Instrumentation" Section of Appendix C of AHRI Standard 550/590. Testing shall, at a minimum, include the following tests performed at the voltage and frequency for the country of installation:

1. Perform system measurements of entering and leaving water temperatures, flow rate, and power input using site design conditions (including ambient dry bulb temperature and water temperatures). Test and rate chiller capacity, energy efficiency, water pressure drops, and NPLV including controlled ambient conditions and concurrent redundant verification of test results using two sets of calibrated instrumentation to concurrently measure water temperatures, flow rates, and power inputs.
2. Demonstrate specified compressor phasing in response to increasing and decreasing load conditions. Demonstrate the chiller runs properly for a minimum of 15 minutes at the minimum published load and record the efficiency in kW/ton at minimum load.
3. For each compressor module, record compressor RLA, discharge pressure, and suction pressure.
4. Demonstrate system protection and automatic restart after the following conditions:

a. High head pressure cut-out
b. Power failure
c. Flow loss

B. Advance Notice: Facilitate witness by OBO/PDCS/DE mechanical engineer representative of source quality-control tests described above. Notify Project Director/COR of testing date and location 14 calendar days in advance. Provide written protocol to be used for testing at notification.

C. Submit Results: Within one week of completed test, submit copy of test results indicating test procedures, instrumentation, test conditions, and results.

2.14 [PACKAGED, PORTABLE REFRIGERANT RECOVERY UNITS

A. Packaged, portable unit consisting of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest chiller furnished.]

PART 3 - EXECUTION

3.1 EXAMINATION / VERIFICATION

A. Examine areas to receive chillers for compliance with requirements for installation tolerances and other conditions affecting chiller performance, maintenance, and operations. Final chiller locations indicated on Drawings are approximate. Prior to roughing-in piping and electrical connections, determine exact locations and verify all dimensions in the field.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Maintain manufacturer's recommended clearances for service and maintenance accounting for roof curbs, equipment supports, roof penetrations, etc.

B. Coordinate sizes and locations of concrete bases or structural steel with actual equipment provided. Install chillers level and plumb.

C. During installation, piping and similar openings must be capped to keep out dirt and other foreign matter.

D. Install electrical components, devices, and accessories furnished loose by manufacturer, including remote flow switches and remote chiller control panel.

E. Insulate evaporator, suction lines, and other surfaces where condensation might occur.

F. Manufacturer's factory-trained service personnel shall charge chiller with refrigerant and fill with oil.

G. Hydronic water system and piping shall be fully installed, flushed, and operational prior to connecting to chillers.

H. Hydronic water treatment system shall be fully functional with correct water chemistry including corrosion inhibitor and shall be demonstrated and stable prior to connecting hydronic piping system to chillers.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Piping Connections: Install piping adjacent to machine to allow service and maintenance. Connect chilled-water piping to chillers with flexible connectors.

    a. Evaporator inlet connection: Include controller-bulb well, shutoff valve, thermometer, strainer, pressure gage, and union or flange.
    b. Evaporator outlet connection: Include shutoff valve, flow switch, balancing valve, thermometer, pressure gage, union or flange, and water pressure relief valve.
    c. Condenser inlet connection: Include shutoff valve, thermometer, plugged tee, and pressure gage.
    d. Condenser outlet connection: Include shutoff valve, thermometer, drain line and shutoff valve, strainer, and plugged tee.

2. Safety-relief: Extend safety-relief valves or rupture-disc discharge piping from chiller and purge condenser receiver to exterior of building.
3. Refrigerant capture: At all times during installation and testing of refrigeration system, take steps to prevent release of refrigerants into the atmosphere. If refrigerant leak is discovered after system has been charged, the leaking portion must be immediately isolated, and refrigerant must be recovered into suitable container.
4. Electrical: Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A - 486B "Wire Connectors."

3.4 CLEANING

A. After completing installation, including outlet fittings and devices, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.5 STARTUP SERVICE

A. Verify that installation complies with the Contract Documents.

B. Engage a factory-authorized service representative to perform startup service.

1. Fill out startup checklists and attach copy with Contractor Startup Report.

C. Complete installation and startup checks according to manufacturer's written instructions and check for the following items:

1. No physical damage to unit.
2. Unit is level.
3. Chiller vibration isolation and flexible pipe connections are installed.
4. Clearances have been maintained and piping is installed for easy removal for service and tube cleaning.
5. Chilled-water pipes have been connected to correct ports.
6. Labels and safety instructions are clearly visible.
7. Oil levels are as recommended by manufacturer.
8. Refrigerant charge is sufficient, and chiller has been leak-tested.
9. Shipping materials such as skids, blocks, and straps are removed.
10. Refrigerant pressure relief is vented to outside.
11. Thermometers and pressure gages are installed.
12. Controls and safety interlocks are installed and connected.
13. Pumps are installed, connected, and operational.
14. Proper motor rotation.
15. Refrigerant detector and alarm have been installed and connected as applicable.

D. Check and record performance of chiller protection devices.

E. Check and record performance of chilled- and condenser-water flow and low-temperature interlocks.

F. Operate chiller for run-in period as recommended by manufacturer.

G. Check static deflection of vibration isolators including deflection during chiller startup and shutdown.

3.6 DEMONSTRATION AND TRAINING

A. Factory-trained technician shall demonstrate and train Government’s maintenance personnel. Provide minimum of two sets of training sessions, recorded for future reference, with each set of session held at a distinctly different time period to accommodate personnel identified by Project Director/COR based on input from Post’s Facility Manager. Each set of sessions shall include 4 hours in classroom and 4 hours of demonstration. Schedule one additional training session during the occupancy adjustment visit to allow post personnel to address operating challenges.

1. Training topics shall include adjusting, operating, and maintaining chillers. Include procedures and schedules related to start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, and alarms for maintaining water chillers in coordination with the complete chilled-water system, instrumentation and control system. Review of control drawings and schematics, data in maintenance manuals, and interactions with other systems.
2. Refer to the Part 3 Article on ARC FLASH TRAINING in Section 260573 “Overcurrent Protective Device Coordination Study” for associated training requirements.

END OF SECTION 236427

SECTION 236434 - MODULAR AIR-COOLED WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, modular air-cooled, electric-motor-driven chillers providing critical cooling for Post Communication Centers (PCCs) and cooling for office buildings and residences.

B. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete” where concrete base is used
2. Section 055005 “Metal Fabrication” where steel framing and supports are used.
3. Division 07 Section on roof accessories.
4. Section 230719 “HVAC Piping Insulation.”
5. Division 23 Section on refrigerant monitoring and safety equipment.
6. Section 260518 “Low-Voltage Electrical Power Conductors and Cables” for connecting electrical and controls wiring.
7. Section 260525 “Grounding and Bonding for Electrical Systems” for grounding water chillers.
8. Section 260573 “Overcurrent Protective Device Coordination Study” for arc flash compliance and training.

1.2 DEFINITIONS

A. EER: Energy-Efficiency Ratio. Ratio of cooling capacity given in terms of Btu/h to total power input given in terms of watts at any given set of rating conditions.

B. IPLV: Integrated part-load value. Single-number part-load efficiency figure of merit calculated per method defined by ARI 550/590 and referenced to ARI standard rating conditions.

1.3 SYSTEM DESCRIPTION

A. Modular Chiller: Modular Chiller shall consist of primary chiller module with additional modules, and shall incorporate the following as identified in Construction Drawings on mechanical equipment schedule:

1. Primary controller and primary power connection.
2. One or more secondary chiller modules.
3. Matching pump module.
4. Building heat exchanger module for PCC chillers.
5. **[Glycol fill shot feeder.]**
6. **[Free cooling module.]**
7. **[Buffer tank module for thermal mass.]**

B. Each mechanical cooling chiller module shall contain:

1. Compressors, including at least one variable speed compressor feeding a condenser coil.
2. Expansion valve.
3. Evaporator heat exchanger.
4. Multiple condenser fans.
5. Quick connect grooved couplings for interconnection to supply and return manifold piping.
6. Power quick connect to allow isolation of module for maintenance and repair.
7. Factory installed controls that do not require onsite programming.

C. Modular chillers shall be sized and configured to meet the full design load plus one additional module for growth/redundancy.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Site Altitude: Chiller shall be suitable for altitude in which installed without affecting performance indicated. Adjust affected chiller components to account for site altitude.

B. Full-Load Efficiency (EER): Provide the following minimum EER at AHRI design of conditions:

1. 10 at 60 Hz.
2. 7 at 50 Hz.

C. IPLV: Provide standard chiller unit with the following IPLV:

1. Less than 0.85 kW/ton for 60 Hz.
2. Less than 0.79 kW/ton for 50 Hz.

D. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and shall be provided with appropriate seismic mounting assemblies for the project site.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: Provide a data sheet (cut sheet) that includes: refrigerant type; oil type; rated capacities; IPLV, EER, shipping instructions; power factor, voltage, frequency, and maximum amperage; operating weights; furnished specialties; and accessories for each model indicated. Indicate breakdown points for chillers shipped in segments.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

C. When location requires seismic restraint, provide restraints and connections set forth in project Div. 23 Specifications.

D. Seismic Design Calculations: Provide calculations for selecting vibration isolators and seismic restraints, and for designing vibration isolation bases.

E. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

F. Wire Diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring. Wiring diagram shall indicate operating voltage and frequency which matches power available at location.

G. Coordination Drawings: Floor plans and elevations drawn to scale and coordinating the following, as appropriate:

1. Structural Supports
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements. Determine spaces reserved for electrical equipment.
4. Access requirements around other work, including working clearances to mechanical controls and electrical equipment, and to any building obstructions which may reduce airflow to condenser coils.

H. Product Certificates: Provide certifications required in the Part 1 Article on QUALITY ASSURANCE, as well as certification that chillers have been factory-tested and function properly. Submit chiller's rated and tested capacity, energy efficiency, and water pressure drop.

I. Source quality-control test reports as required in the Part 2 Article on SOURCE QUALITY CONTROL. Include copy in Operating and Maintenance Manual. Submit an extra copy for Post Facility Manager.

J. Field Report: Prepare written startup report that records results of tests and inspections. Include copy in Operating and Maintenance Manual. Submit an extra copy for Post Facility Manager.

K. Reports on Routine Maintenance Checks: Installing Contractor shall submit documentation that all normal maintenance checks have been conducted commencing with site start up and continued to substantial completion. Installing contractor shall submit completed maintenance logs at manufacturer's required periodicity. The maintenance logs shall indicated they were reviewed by the manufacturer.

L. Maintenance Data: For each chiller to include in maintenance manuals. Include information regarding availability of spare parts in the country where this unit is to be deployed.

M. Written Government Acceptance.

N. Warranty: Documentation in support of requirements in the Part 1 Article on WARRANTY. Include certification that maintenance during the warranty period has been completed in accordance with warranty provisions.

1.6 QUALITY ASSURANCE

A. AHRI Rating: Signed by manufacturer, certifying chiller has been tested and rated in accordance with the requirements of AHRI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle," including concurrent redundant verification of test results on AHRI test stand using two sets of calibrated instrumentation to concurrently measure water temperatures, flow rates, and power inputs.

B. ASHRAE Certification: Signed by manufacturer, certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

C. Comply with the OBO Electrical Code (NFPA 70, National Electrical Code as amended by OBO).

D. Comply with UL 1995.

E. Government Acceptance: After Designer of Record has reviewed and approved chiller submittals, contractor shall obtain mandatory written acceptance of chiller submittals from Project Director/COR based on input from OBO/PDCS/DE mechanical engineer assigned to project prior to procurement of each chiller.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant or nitrogen.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 07 Section on roof accessories.

1.9 WARRANTY

A. Refrigeration Compressor Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace compressors that fail within specified warranty period.

1. Failure includes, but is not limited to, inability to maintain set temperature.
2. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials identified below. Package extra materials with protective coating for storage and identification labels describing contents.

1. Primary module controller.
2. Secondary module controller.
3. Power phase monitor.

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Multistack LLC: Multistack Packaged Air-Cooled Scroll Chiller.
2. Artichill.

2.2 MODULAR CHILLERS

A. Air-Cooled Modular Chiller Description: Factory-assembled and tested water chiller complete with casing, compressor(s), heat exchanger(s), condenser coils and fans, pumps, glycol shot feeder fill system, expansion tank, buffer tank, controls integrated with compressor operation, interconnecting unit piping and wiring, indicated accessories, and mounting frame. Provide:

1. Cabinet: Provide lifting base, structural frame, and weatherproof housing constructed per the requirements of Tables 2.2-1 and 2.2-2. Coat base, frame, and housing with a corrosion-resistant coating capable of withstanding a 1000-hour salt-spray test (5500 hour salt spray test for moderate or extreme marine locations) according to ASTM B 117 with a minimum ASTM 1654 rating of “6.” If base and frame are constructed of stainless or hot dipped galvanized steel, coating is not required. Provide pitched roof on cabinet to prevent water accumulation.
2. Acoustical compressor wrap.
3. Fans: Propeller type, statically and dynamically balanced, with vertical air discharge for high efficiency and low sound; and equipped with heavy-gage, weather-protected fan guard. In moderate or extreme marine locations, fans shall be A/C type motor with FRP (Fiberglass Reinforced Plastic) type blades with corrosion treated hub and washdown duty motors.
4. Fan Motor: Direct drive, weatherproof, with bearings permanently lubricated, and having built-in current- and thermal-overload protection.

5. Modules shall be capable of being hoisted in an elevator having 1200 kg capacity and fit through a 0.75 x 2.00 meter Forced-Entry Ballistic-Resistant (FE/BR) door.
6. Each module shall include manifold supply and return mains for chilled water constructed of the material required in Tables 2.2-1 and 2.2-2. Provide cut grooved end connections

for interconnection to DN 100, 150, or 200 (4-, 6-, or 8- inch standard) piping with Victaulic type couplings.

7. Electrical connections, piping, pumps and chiller location shall be capable of accepting additional modules to incrementally increase chiller capacity for the space served. Minimum expansion capacity shall be 105 kW.
8. Provide chiller array with a single point power connection. This shall include pre-engineered wiring for field installation and connection to a factory mounted chiller junction box. The electrical junction box shall incorporate a through the door disconnect with over-current protection. Junction box shall include individual circuit breakers for each Module and two spares, and provide a single point of connection to building power.

9. Each air-cooled modular chiller include have the following: Minimum two independent refrigerant circuits; each circuit shall include expansion valve, liquid shutoff valve, filter drier, sight glass with moisture indicator, liquid line solenoid valve, and insulated suction line.
10. Provide motorized variable flow valves on each module when pumps are variable speed.

B. Air Cooled Modular Chiller Construction: Water chiller shall be constructed in accordance with the requirements of Table 2.2-1 and Table 2.2-2 based on the application (PCC or Building Cooling) and site location (Inland or Marine).

C. Fabricate water chiller mounting frame and attachment to the pressure vessel with reinforcement strong enough to resist water chiller movement during a seismic event.

TABLE 2.2-1
MODULAR CHILLER REQUIREMENTS – BUILDING COOLING APPLICATION

COMPONENTS	INLAND LOCATION	MARINE LOCATION
Module Configuration	N+1 Provide chiller with capacity sized per OBO-ICS IMC Ch. 3	N+1 Provide chiller with capacity sized per OBO-ICS IMC Ch. 3
Coil Tube & Fins	Copper & Copper	Copper & Copper
Coil Coating	None	Heresite or Electrofin
Manifolds	Stainless steel inlet and stainless steel Teflon coated inline strainer; minimum 30 mesh and minimum 550 square inches of surface area per module	Stainless steel E/L and stainless steel Teflon coated inline strainer; minimum 30 mesh and minimum 550 square inches of surface area per module
Pumps	Cast iron housing; bronze impeller; variable frequency drive	Stainless steel housing; bronze impeller; variable frequency drive
Housing	Galvanized steel or aluminum with 304 stainless steel fasteners	Galvanized steel w/ factory-applied powder coat epoxy finish with 304 stainless steel fasteners
Structural Frame	Galvanized steel or aluminum with 304 stainless steel fasteners	Galvanized steel w/ factory-applied powder coat epoxy finish with 304 stainless steel fasteners
Lifting Base	Painted structural steel	Hot dip galvanized steel
Control Panel	On chiller	On chiller
[Hydronic Buffer Tank]	160 gallon minimum	160 gallon minimum
System Strainer	Cast iron duplex or parallel isolatable strainers	Cast iron duplex or parallel isolatable strainers
Pump and Chiller Service/Isolation Valves	Carbon Steel	Stainless Steel
Glycol Feeder System	Where weather conditions require; provide minimum 190 Liter mixing tank	Where weather conditions require; provide minimum 190 Liter mixing tank
“Fail-to-Run” Controls	As described under CONTROLS Article	As described under CONTROLS Article

TABLE 2.2-2
MODULAR CHILLER REQUIREMENTS – PCC CRITICAL COOLING APPLICATION

COMPONENTS	INLAND	MARINE
Module Configuration	N+1 (Maintain 100 percent of load with 1 module offline)	N+1 (Maintain 100 percent of load with 1 module offline)
Coil Tube & Fins	Copper & Copper	Copper & Copper
Coil Coating	Heresite or Electrofin	Heresite or Electrofin
Manifolds	Stainless steel E/L and stainless steel Teflon coated inline strainer minimum 30 mesh and minimum 550 square inches of surface area per module	Stainless steel E/L and stainless steel Teflon coated inline strainer minimum 30 mesh and minimum 550 square inches of surface area per module
Pumps	Stainless steel housing; cast stainless steel impeller; constant speed	Stainless steel housing; cast stainless steel impeller; constant speed
Housing	Galvanized steel or aluminum with 304 Stainless Steel Fasteners	304 Stainless steel with 304 Stainless Steel Fasteners
Structural Frame	Hot dip galvanized steel	Stainless steel
Lifting Frame	Hot dip galvanized steel	Hot dip galvanized steel
Make-Up Water Source	From glycol/H2O shot feeder	From glycol/H2O shot feeder
Building Heat Exchanger	Sized for PCC full load	Sized for PCC full load
Control Panel	One on chiller, plus one remote, wall-mounted in PCC	One on chiller, plus one remote, wall-mounted in PCC
Hydronic Buffer Tank	Stainless; Sized to achieve system hydronic volume > 30.3 L (8 gal) per ton	Stainless; Sized to achieve system hydronic volume > 30.3 L (8 gal) per ton
Duplex Basket Strainer	Bronze	Bronze
Pump and Chiller Isolation Valves	Stainless Steel	Stainless Steel
Frame < 29” wide	Site Specific to FEBR Access	Site Specific to FEBR Access
“Fail-to-Run” Controls	As described under CONTROLS section of specification	As described under CONTROLS section of specification
Glycol Feeder System	19 L mini shot feeder required for all building locations	19 L mini shot feeder required for all building locations

Notes to Tables 2.2-1 and 2.2-2:

1. Hot-dipped galvanized members shall have all penetrations made before the galvanization is done to minimize early rusting. Minimum coating thickness shall be 70 micrometers (1.60 oz. of zinc per sq. ft.).
2. Inland Location and Marine Location relate to project-specific requirement to address corrosion resistance. Refer to the Part 1 Article on SYSTEM PERFORMANCE REQUIREMENTS.

2.3 COMPRESSORS

A. Description: Positive displacement direct drive with, crankcase oil heater and suction strainer. Provide suction and discharge service valves when modules contain multiple independent refrigeration circuits. The compressor system shall be capable of operating at part-load conditions without increased vibration over normal vibration at full-load operation and shall be capable of continuous operation at its lowest step of unloading.

B. Refrigerant: Refrigerant must be one of the fluorocarbon gases with number designation and safety classification in accordance with ANSI/ASHRAE 15 & 34. CFC-based refrigerants are prohibited. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0. Provide Safety Data Sheets (SDS) for all refrigerants. Refer to US EPA Significant New Alternatives Policy (SNAP) for more information.

C. Refrigerant Compatibility: Seals, O-rings and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

D. Rotating parts shall be statically and dynamically balanced to ISO 1940/1-1986, G16, or G6.3 as specified.

2.4 HEAT EXCHANGERS

A. Evaporator:

1. Description: Provide brazed plate design, fabricated and tested in accordance with UL 1995 code.
2. Material: 316 Stainless steel.
3. Working pressures: Refrigerant side: 3100 kPa Water-side: 1035 kPa.
4. Connections – Refrigerant: Threaded or brazed.
5. Connections – Water-side: Cut grooved.

B. Condenser Coil: Seamless copper tubes with mechanically bonded copper fins. Integral sub-cooling circuit, leak tested at 3100 kPa.

1. Fins: Provide copper fins. Fins shall be spaced at a minimum of 4.7 fins per centimeter.
2. Corrosion-Resistant Coal Coating: Provide in accordance with Tables 2.2-1 and 2.2-2. Where required, coating method and dry film thickness shall be in accordance with coating manufacturer recommendations.

3. Safety and Operating Options: For cold climates, provide low-ambient controls for operation down to –10 deg C.

2.5 BUFFER TANK

A. Provide an ASME labeled, insulated, and PVC-jacketed tank (38 mm thickness, closed coil flexible elastomeric thermal insulation), with internal baffle to maximize utilization of tank volume without mixing, pressure rated at 1035 kPa minimum. Size tank in accordance with designer's system volume calculation for a 2 minute or greater loop.

2.6 INSULATION

A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation with thermal conductivity of 0.26k (BTU/HR-FT^2-deg F/in.) maximum. Insulation shall conform to ASTM C 534, Type II, for sheet materials. See tables in Section 230719 "HVAC Piping Insulation."

1. Thickness: 19 mm minimum. Increase insulation thickness to 38mm in high humidity environments to prevent sweating.
2. Adhesive: Provide adhesive recommended by insulation manufacturer.
3. Insulation: Provide Factory applied insulation over entire surfaces of water chiller components.

a. Apply adhesive to 100 percent of insulation contact surface.
b. Seal seams and joints.

2.7 ACCESSORIES

A. For locations having ASHRAE 99 percent heating days below 7.0 deg. C, provide low-ambient head pressure kit.

B. Provide redundant chilled water differential pressure switches for proof of flow. Switches should be installed in parallel such that if one of the switches fails, chiller pump operation will not be disabled.

C. Provide refrigerant suction and discharge pressure gages for each independent refrigerant circuit.

D. For locations having ASHRAE 99 percent cooling days above 40 deg C provide high-ambient condenser option. **[EER may be decreased to 9.2 for 60 Hz units and 9.8 for 50 Hz units.]**

E. Power Factor Correction: Provide power factor correction with chiller to meet or exceed a power factor of 0.95 unless contractor certifies that power factor correction shall be provided at the site level to ensure site power factor does not fall below 0.95.

F. Special Tools Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished that contains any special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.

Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and affix the list to underside of case cover.

G. For PCC chillers, which require critical cooling, provide refrigerant reclaim kit for selected refrigerant that includes refrigerant reclaim unit and cylinders to fully evacuate refrigerant charge, vacuum pump to evacuate refrigerant circuit after repairs are made, and spare refrigerant to fully charge a circuit, as well as refrigerant technician hose and gauge set.

2.8 MISCELLANEOUS EQUIPMENT MODULES

A. Chiller shall be completely assembled and pre-piped on a common skid with pump package module and glycol feeder system. Chiller shall be completely factory assembled and tested prior to shipment. Manufacturer designs shall be directly suitable for outside environment.

B. Pump Package Module: Module shall include dual in-line centrifugal pumps per Division 23 Section on hydronic pumps, with premium efficiency motors as specified in Division 23 Section on common motor requirements for HVAC equipment, in a primary/standby pumping arrangement piped into a common header. Pump starters and controls shall be provided to enable manual selection of lead pump. In addition, in the event of a loss-of-flow failure of the chilled water system, the Pump Module controls shall disable the lead pump and automatically start the standby pump. Pump Package shall include isolation valves to allow for servicing of the standby pump while the primary pump is operating. Include inlet and outlet pressure and temperature gauges.

C. Glycol Feeder System: System shall be connected through the common chiller header system requiring no additional water connections. System shall include the following glycol related equipment: a minimum of 190 liter storage/mixing tank with lid and cover for a main building chiller or a mini 19 liter shot feeder for a PCC chiller; pump suction hose with inlet strainer; pressure pump with thermal cut-out and integral pressure switch; pre-charged accumulator tank with EPDM diaphragm, manual diverter valve for purging and agitating contents of storage tank; adjustable 170-380 kPa pressure regulating valve with pressure gauge, fast fill level, integral replaceable strainer, built-in check valve, and built in shut-off valve. Glycol feeder systems shall be compatible with glycol solutions of up to 50 percent concentration. Pump shall be capable of running dry without damage. Provide low level sensor in shot feeder /tank that communicates an alarm to the remote control panel or Building Automation System (BAS) system. The module shall also include an expansion tank of welded steel with butyl rubber diaphragm and capable of a maximum operating temperature of 115 deg C and maximum working pressure of 690 kPa. The expansion tank shall be interconnected through the common chiller header system and require no additional water connections.

D. Free Cooling Module Option: Module shall interconnect with common chiller header system and require no additional water connections. Free Cooling Module shall include glycol cooling coil manufactured same as for condenser coil, temperature-controlled condenser fans, and an automatic 3-way bypass valve to eliminate the need for mechanical cooling under low ambient conditions. Operating controls shall be pre-wired in the equipment control panel. Free Cooling Module shall be in a completely separate assembly from the Mechanical Cooling Modules. No common condenser/free-cooling fans shall be accepted.

2.9 CONTROLS

A. Control Panel: Stand-alone, microprocessor-based control panel shall be located on the chiller.

B. Enclosure: Unit-mounted, NEMA 250, Type 1 enclosure, hinged or lockable; factory wired with a single-point power connection and a separate control circuit.

C. Phase Monitor: Provide SymCom brand or approved equal. This device shall prevent chiller from operating during periods when incoming power is unsuitable for proper operation. Power Phase Monitor shall provide protection against the following conditions:

1. Over and Under Voltage (Brown-Out)
2. Phase Rotation
3. Loss of Phase
4. Phase Imbalance

D. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad. Display the following conditions. Edit list below to suit Project. Verify availability; status displays may vary depending on unit size:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outside-air temperature if required for chilled-water reset.
5. Temperature and pressure of operating set points.
6. Entering and leaving temperatures of chilled water.
7. Refrigerant pressures in evaporator and condenser.
8. Saturation temperature in evaporator and condenser.
9. No cooling load condition.
10. Elapsed time meter (compressor run status).
11. Chilled water flow status.
12. Anti-recycling timer status.
13. Load-limit set point.
14. Compressor run hours.

E. Control Functions: Edit list below to suit Project. Verify availability; functions may vary depending on unit size:

1. Manual or automatic startup and shutdown.
2. Entering and leaving chilled-water temperature, control set points, and motor load limit. Chilled-water temperature shall be reset based on return-water temperature.
3. External water chiller emergency stop.
4. Anti-recycling timer.
5. Automatic lead-lag switching.

F. Manually Reset Safety Controls: The following conditions shall shut down the respective compressor module in which they occur and require manual reset. Edit list below to suit Project. Verify availability; conditions may vary depending on unit size:

1. Low evaporator pressure or high condenser pressure.
2. Low chilled-water temperature.
3. Refrigerant high pressure.
4. Controller.
5. Compressor motor current-overload.

G. Building Automation System (BAS) Interface: For building cooling chillers provide factory-installed hardware and software to enable the BAS to monitor and control chilled-water set point and chiller-control displays and alarms.

1. Provide communication interface with building automation system using BACNET protocol matching BAS protocol, which shall enable building automation system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building automation system.

H. Additional Remotely-Located Control Panel: When chiller is used for critical cooling of PCCs, provide a remotely-located control panel capable of operating all chiller controls, including starting and stopping the chilled water pumping system and chiller system. All information shall be available through LCD display provided on remote panel. Provide the following LED indicators on the panel:

1. System Normal
2. Chiller fault
3. Flow fault
4. Chiller Water Temperature Fault
5. Pump alarm
6. Glycol shot feeder low level alarm

I. Fail-to-Run Controls: Provide an integrated “Fail-to-Run” control system. This system shall automatically put all chilling modules in “OVERRIDE MODE” in the event of any system failure that would otherwise cause a system shut-down, such as: low leaving chilled water temperature; no chilled water flow; power phase monitor fault; communication fault.

2.10 MOTORS

A. Refer to Division 23 Section on common motor requirements for HVAC equipment for general requirements.

B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

1. Open-drive motors shall have flanged or flexible coupling suitable for direct connection to compressor.

2.11 SOURCE QUALITY CONTROL

A. Factory test fully assembled water chillers before shipping, according to a written protocol. Provide test report indicating test instrumentation, test conditions, acceptable limits for test results, and results. Testing shall, at a minimum, include the following tests performed at the voltage and frequency for the country of installation:

1. Perform system measurements of entering and leaving water temperatures, flow rate, and power input. Calculate total system capacity and efficiency in kW/ton.
2. Demonstrate specified compressor phasing in response to increasing and decreasing load conditions.
3. For all modules, record compressor RLA, fan FLA, discharge pressure, suction pressure.
4. For the pump module, record water flow rate and the total pressure and FLA for each pump.
5. Demonstrate system protection and auto-restart after the following conditions:

    a. Phase loss
    b. Power failure
    c. Flow loss
    d. Over voltage
    e. Under voltage
    f. High head pressure cut-out

6. Demonstrate Fail-to-Run and Emergency Operation controls (for PCC chiller only).
7. Demonstrate remotely-located control panel (for PCC chiller only) operation.

B. If code evaporator pressure vessel is utilized, factory test and inspect evaporator according to UL 1995.

C. Rate sound power level for chillers located outdoors according to ARI 370 procedure. Test the chiller operating at calculated worst-case sound condition. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Noise levels at the site boundary of the facility shall comply with the host country's noise laws and regulations. When local standards do not exist, noise shall not exceed 55 dB(a) (daytime) and 45 dB(a) (nighttime) using the "A-Weighted Sound Level." All vibrating, reciprocating and rotating equipment mounted to the roof or the building structure shall be isolated from its associated piping/ducting and the building structure.

D. Facilitate witness by OBO/PDCS/DE/ME representative of source quality-control tests described above; notify Project Director/COR of testing date and location 14 days in advance. Provide written protocol to be used for testing at notification.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Final water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install water chillers on concrete base. Concrete base is specified in Division 23 Section, and concrete materials and installation requirements are specified in Section 033000 “Cast-in-Place Concrete.”

B. Concrete Bases: Anchor chiller mounting frame to concrete base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 450-mm centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Cast-in-place concrete materials and placement requirements are specified in Section 033000 “Cast-in-Place Concrete.”

C. Vibration Isolation: Vibration isolation devices and installation requirements shall conform to the requirements of the OBO Building Code (International Building Code as amended by OBO). See Division 23 Section on vibration and seismic controls for HVAC piping and equipment for additional requirements.

D. Maintain manufacturer’s recommended clearances for service and maintenance.

E. Charge water chiller with refrigerant and oil if not factory charged.

F. Install separate devices furnished by manufacturer.

3.3 CONNECTIONS

A. Chilled and condenser-water piping installation requirements are specified in Division 23 Section on hydronic piping. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer, strainer, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, flow switch, balancing valve, thermometer, pressure gage, and union or flange.

D. Provide domestic make-up water connection with back flow preventer for main building chiller applications.

E. Refrigerant Pressure Relief Valve Connections: Extend vent piping to the outside without valves or restrictions when required by ASHRAE 15.

F. Ground water chillers according to Section 260525 ”Grounding and Bonding for Electrical Systems.”

G. Chiller shall be provided with factory installed and wired main disconnect switch and a single point power connection. This includes pre-engineered wiring for field installation and connection to a factory mounted chiller junction box. Junction box shall include individual circuit breakers for each Module Set and two spares, and provide a single point of connection to building power. Connect wiring at single connection point according to Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

H. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 START-UP SERVICE

A. Engage a technician, factory trained on equipment being installed, to inspect field-assembled components and equipment installation, including piping and electrical connections, and to perform testing startup service.

1. To facilitate OBO/PDCS/DE/ME representative witness of testing and start-up service, notify Project Director/COR of testing date and location 14 days in advance.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer’s written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate chiller for run-in period according to manufacturer’s written instructions.
5. Check bearing lubrication and oil levels.
6. Verify proper motor rotation.

7. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
8. Verify and record performance of water chiller protection devices.
9. Verify proper compressor phasing in response to increasing and decreasing load conditions.
10. Test and adjust factory-mounted (and if used remote panel) controls and safeties. Replace any and all damaged or malfunctioning controls and equipment.

D. Installing contractor shall submit completed maintenance logs at manufacturer's required periodicity to Project Director / COR certifying that maintenance during the warranty period has been completed. The maintenance logs shall indicated they were reviewed by the manufacturer.

3.5 DEMONSTRATION AND TRAINING

A. Factory-trained technician shall demonstrate and train Government's maintenance personnel. Provide minimum of two sets of training sessions, with each session held at a distinctly different time period to accommodate personnel identified by Project Director/COR based on input from Post's Facility Manager. Each set of sessions shall include 4 hours in classroom and 4 hours of demonstration. Schedule one additional training session during the occupancy adjustment visit to allow post personnel to address operating challenges.

1. Training topics shall include adjusting, operating, and maintaining chillers. Include procedures and schedules related to start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, and alarms for maintaining water chillers in coordination with the complete chilled-water system, instrumentation and control system. Review of control drawings and schematics, data in maintenance manuals, and interactions with other systems.
2. If remote panel is installed, include training on PCC operators where applicable.
3. Refer to the Part 3 Article on ARC FLASH TRAINING in Section 260573 "Overcurrent Protective Device Coordination Study" for associated training requirements.

END OF SECTION 236434

SECTION 237315 – CENTRAL-STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section identifies requirements for air handling units (AHU) in the construction of new and renovation of existing office buildings and on-compound housing.

B. Related Sections:

1. Filters and filter housing requirements for HVAC applications not protected by environmental security protection systems are addressed in Section 234105 "Air Filtration.
2. Section 250593 "Testing, Adjusting, and Balancing for HVAC."
3. Motor requirements are addressed in Division 23 Section on common motor requirements for HVAC equipment, except where otherwise specifically identified in this Section.

1.2 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):

1. AHRI 410: Forced Circulation Air-Cooling and Air-Heating Coils.
2. AHRI 640: Performance Rating of Commercial and Industrial Humidifiers.
3. AHRI 850: Commercial and Industrial Air Filter Equipment.
4. AHRI 1060: Performance Rating of Air-to-Air Exchanges for Energy Recovery Ventilation Equipment.
5. AHRI 1350: Mechanical Performance Rating of Central Station Air-Handling Unit Casings.

B. Air Movement and Control Association International, Inc. (AMCA):

1. AMCA 99: Standards Handbook.
2. AMCA 210: Methods of Testing Fans for Aerodynamic Performance Rating.
3. AMCA 300: Reverberant Room Method for Sound Testing of Fans.
4. AMCA 301: Methods for Calculating Fan Sound Ratings form Laboratory Test Data.
5. AMCA 500-D: Laboratory Methods of Testing Dampers for Rating.

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

1. ASHRAE 33: Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils.
2. ASHRAE 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
3. ASHRAE 62.1: Ventilation and Acceptable Indoor Air Quality.
4. ASHRAE 62.2: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.
5. ASHRAE 84: Method of Testing Air-to-Air Heat/Energy Exchangers.

6. ASHRAE 90.1: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

D. American Society of Mechanical Engineers (ASME):

1. ASME AG-1: Code on Nuclear Air and Gas Treatment.
2. ASME N509: Nuclear Power Plant Air-Cleaning Units and Components.
3. ASME NQA-1: Quality Assurance Requirements for Nuclear Facility Applications.

E. American Welding Society (AWS):

1. AWS D1.1: Structural Welding Code – Steel.
2. AWS D9.1: Sheet Metal Welding Code.

F. ASTM International:

1. ASTM A312: Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
2. ASTM A554: Standard Specification for Welded Stainless Steel Mechanical Tubing.
3. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM B75M: Standard Specification for Seamless Copper Tube.
5. ASTM B88: Standard Specification for Seamless Copper Water Tube.
6. ASTM B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.
7. ASTM C920: Standard Specification for Elastomeric Joint Sealants.
8. ASTM D714: Standard Test Method for Evaluating Degree of Blistering of Paints.
9. ASTM D3467: Standard Test Method for Carbon Tetrachloride Activity of Activated Carbon.

G. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 519: IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.

H. Institute of Environmental Sciences and Technology (IEST):

1. IEST-RP-CC001: HEPA and ULPA Filters.
2. IEST-RP-CC008: High-Efficiency Gas-Phase Adsorber Cells.

I. International Organization for Standardization (ISO):

1. ISO 5011: Inlet air cleaning equipment for internal combustion engines and compressors - Performance testing.
2. ISO 14694: Specifications for balance quality and vibration levels.

J. National Electrical Manufacturers Association (NEMA):

1. NEMA MG1: Motors and Generators.

K. Underwriters Laboratories (UL):

1. UL 486A-486B: Wire Connectors.
2. UL 586: Standard for High-Efficiency, Particulate, Air Filter Units.
3. UL 723: Tests for Surface Burning Characteristics of Building Materials.
4. UL 900: Standard for Air Filter Units.

1.3 DEFINITIONS AND ABBREVIATIONS

A. AHU: Air Handling Units.

B. ASZM-TEDA: Impregnate applied to activated carbon for use in HEGA filters.

C. High Efficiency Gas Adsorption (HEGA) Filters: Filters with one or more adsorbents (e.g., activated carbon, impregnated carbon, activated alumina, zeolites, and molecular sieves) used to remove airborne toxic chemicals.

D. High Efficiency Particulate Air (HEPA) Filters: Filters typically used in industry in hospital operating rooms and manufacturing clean rooms.

E. Indoor Air Quality (IAQ): Air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. IAQ can be affected by gases (e.g., carbon monoxide, volatile organic compounds), particulates (measured in outdoor air and reported as PM10 and PM2.5), and microbial contaminants (e.g., bacteria, mold). Outdoor (and some indoor) pollutants can be created from a variety of sources to include the decay of radioactive elements (e.g., radon), local motor vehicles (e.g., nitrogen oxides, sulfur dioxide, carbon monoxide), manufacturing plants (e.g., toxic industrial chemicals, volatile organic compounds). To provide occupant health and comfort, and to enhance productivity, contaminant levels are controlled utilizing a variety of best practices, including building pressurization and gas/particle filtration.

F. Inertial Separator: Used to extend life of particulate filters by separating heavy airborne particles as air changes direction.

G. Marine Climate: See Appendix W of the OBO Building Code.

H. MERV: Minimum Efficiency Reporting Value as defined by ASHRAE Standard 52.2.

I. Outdoor-Air Pollution Control Filter (OAPCF): Single or combination (e.g., MERV 13, HEGA, adsorption media impregnated bag filters, etc.) of various particulate and/or gas adsorption filters which control contaminants and pollutants to achieve acceptable indoor air quality. Control of humidity, dust, and rain at the pollution control filters is critical to operation and life of the Environmental Security filtration system components.

J. Sub-Arctic/Very Cold/Cold/Mixed: Climate that is sub-arctic, very cold, cold, or mixed as defined by ANSI/ASHRAE/IESNA Standard 90.1.

K. Toxic Industrial Chemicals (TIC): Chemical hazards (e.g., carcinogens, reproductive hazards, corrosives, agents that affect lungs or blood) or physical hazards (e.g., flammable, combustible, explosive, reactive).

L. Volatile Organic Compounds (VOC): Any compound of carbon (apart from carbon monoxide, carbon dioxide, carbonic acid, metallic carbides, and carbonate ammonium carbonate) that participates in atmosphere photochemical reactions, except for those designated by EPA as having negligible reactivity.

1.4 SUBMITTALS

A. Preconstruction Submittals: Copy of Export License (DOS Form DSP-83) for export-controlled ASZM-TEDA carbon, or certification that no license is required. See Article on MARKING, PACKING, SHIPMENT, AND STORAGE.

B. Shop Drawings: Submit AHU room layout drawn to scale with equipment properly configured with conformance to access (e.g., coil pull and filter change).

1. Identify all maintenance space requirements, including space reserved to facilitate coil pull.
2. Identify all ductwork and piping entering and leaving AHU room in plan and elevation.
3. Indicate hose bibb and floor drain locations in each AHU room to facilitate cleaning of coils.
4. Indicate maintenance platform around AHU as required to facilitate maintenance.

C. Product Drawings: Provide dimensioned plan and section views for each air handling unit including the following information:

1. Equipment section breaks, external components (e.g., dampers, intakes with bird/bug screens, security grills, rain/snow entrainment, deicing/icing control system, dust and sand capture devices, etc.), internal components (e.g., dampers, filter housing, filters, grates, coils, etc.), equipment pad, chilled/hot water piping connections, drain/condensate drain piping and trap/trap primer locations and sizes, and inlet and outlet duct connection locations. Indicate location of control dampers, if installed internally, with location of actuator assembly.
2. **[Humidifiers: Show minimum length of straight duct downstream of humidifier and associated condensate drip pan.]**
3. Filter Housings: Provide dimensional plans and elevations of filter.
4. Cooling and heating coils, including corrosion control systems, as applicable: Clearly show location and “pull space” for coil replacement.
5. Access Doors and Access Panels: Indicate size and location of equipment access doors and panels, latch location, and direction path of door swing.
6. Electrical and Building Automation System (BAS) Control Elements: Indicate location of fan motor power junction box, variable frequency drives, electrical door switch junction box, and Magnehelic®/reporting pressure gauges.
7. **[Electric Duct Heater: Indicate location of electric duct heater with exterior mounted power and control panel.]**

D. Product Data:

1. Motors: Motors and variable frequency drives.
2. Fans.
3. Coils.
4. Humidifiers.
5. Insulation: Submit insulation material data sheet. Indicate insulation thickness and R-value. If AHU is to be installed in non-conditioned or outdoor location, submit calculations verifying that unit will not sweat under design conditions.
6. Casing: Submit no-thru-metal design construction sheets and materials that meet corrosive conditions at the intended site.
7. Filter Housings: Submit data which confirms that internal construction components of filter housings are stainless steel or as otherwise specified in this Section.
8. Filters: Submit following data on all filters selected for each AHU:

    a. Filter media.
    b. Framework construction.
    c. Physical dimensions required for clearances and access space.
    d. Weights.
    e. Securing methods.
    f. Fire classification.
    g. Rated flow capacity.
    h. Initial and final pressure drops at scheduled air flow.
    i. Particulate MERV rating.
    j. Gas adsorption residence time.
    k. Expected lifespan and replacement schedule.
    l. Test method.
    m. Operating/storage limits regarding temperature and humidity.

E. Design Data:

1. Derating Equipment: Provide derating corrections for all AHU components as necessary for proper operation at sites with elevation greater than or equal to 500 meters above sea level. Identify necessary derating corrections for heat transfer fluid (baseline: water) and power (e.g., frequency, voltage).
2. Pressure: Static pressure profile for each AHU that shows external static pressure broken down into supply air and return air components, individual AHU component static pressure losses, fan derating for system, and AHU exit loss at design airflow. Provide separate tables for clean and dirty filter operating conditions.
3. Leakage: Leakage compliance data for opposed blade dampers as specified in this Section.
4. Coils and Fins: Identify rated flow and heat transfer data for cooling and heating coils with applicable corrosion control, both waterside and airside, at design and maximum operating points. For cooling coils, separately annotate latent heat transfer data.
5. Filters: Identify quality (at design condition) of ventilation air (temperature and humidity). Submit particulate and gaseous media selection calculations based upon ASHRAE 62.1 or 62.2 (as applicable) IAQ standards for the worst-case local microclimate conditions. Calculations must support specific recommended filter change schedule provided in O&M

manual. Analysis must include life cycle cost of OAPCF and associated impact on replacement frequency of HEGA ASZM-TEDA filters.

6. Fan Data: Fan performance curves and data table indicating system operating conditions at rated design operating points (both minimum and maximum design airflows) for both clean and dirty filters.
7. Acoustic Summary Data: Provide Sound Power Level table in dBA for inlet openings in mixing plenum and plenum fan discharge. Provide Casing Radiation Sound Level data in dBA for supply fan section. Data must be based at design airflow rate and maximum total pressure of each AHU.

F. Test Reports:

1. Testing Agency Qualifications: Submit qualifications for independent testing agency.
2. Testing Protocols: Submit testing protocols to Project Director/COR for receipt by OBO/PDCS/DE Mechanical Engineer representative.

   a. Factory Testing: Receipt must be at least seven days in advance of test.
   b. Field Testing: Receipt must be at least 14 days in advance of test.
   c. Commissioning and Startup Service: Receipt must be at least 14 days in advance of test. Itemize equipment and materials required on site; list each performance test to be conducted and describe desired outcome of each commissioning test.

3. Factory AHU Casing Pressure Test: Prior to shipping, submit data for test signed by testing official from testing performed in accordance with Article on FACTORY ACCEPTANCE TESTING.
4. Factory Filter Housing Test: Submit data for test signed by testing official from testing performed in accordance with Article on FACTORY ACCEPTANCE TESTING. Include the following:

   a. Filter Housing Test Report from manufacturer of filter frame manifold(s) in housing.
   b. HEGA media lot acceptance test data for each lot; submit when filters are shipped.

5. Field AHU Casing Pressure Test: For modular AHU assembled in field, submit data for test signed by testing official from testing performed in accordance with Article on FIELD QUALITY CONTROL.
6. Field Filter Bypass Test: Submit data for test signed by testing official from testing performed in accordance with Article on FIELD QUALITY CONTROL. Include the following:

   a. Testing Equipment: Provide list of equipment used along with current calibration certificate.
   b. Field Quality Test Report: This Report will be forwarded by Project Director/COR to OBO/OPS/FAC for inclusion in Maintenance Database.

7. Field AHU System Leakage Test: Submit data for test signed by testing official from testing performed in accordance with Article on FIELD QUALITY CONTROL.

G. Certificates: For certification as identified in Article on QUALITY ASSURANCE.

H. Operations and Maintenance Manuals.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain all AHU assemblies from a single source, which assumes responsibility for compatibility with each HVAC system.

B. Testing Agency Qualifications: Independent agency with experience and capability to conduct testing included in this Section that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/ME.

C. Certification: Certify compliance with the following:

1. Motors: Conventional efficiency testing is performed in accordance with NEMA MG 1. Motors comply with NEMA standards and are matched to torque and horsepower requirements of load. Motors have electrical insulation in accordance with Article on MOTORS AND VARIABLE FREQUENCY DRIVES.
2. Variable Frequency Drive Controllers: Design and rating of motors for use with variable frequency drive controllers are suitable for use throughout entire speed range without overheating.
3. Electrical Components and Wiring: Testing indicated in the OBO Electrical Code (NFPA 70 as amended by OBO) for items identical to those used in other Sections of this project Construction Specification. Systems must be listed and labeled for intended use.
4. Welding Certify that manufacturer uses skilled, certified welders for this construction. Welding procedures and personnel certifications must be in accordance with AWS D1.1 and AWS D9.1 for casing joints, filter housings, and seam welding.
5. Cooling and Heating Coils: Compliance with AHRI 410.
6. Humidifiers: Compliance with AHRI 640 “Standards for Commercial Humidifiers.”
7. Filters:

    a. Compliance with NFPA 90 series for fire classifications, ASHRAE 52.2 for testing and rating air filters, and AHRI 850.
    b. HEPA Filters: Compliance with either IEST-RP-CC001.
    c. HEGA Filters: Compliance with IEST-RP-CC008, MIL-DTL-32101 for ASZM-TEDA Carbon, and Section TA of ASME AG-1 for High Efficiency Air Cleaning Devices (applicable sections). Certify filter housings and filters are designed, manufactured, and tested in accordance with quality assurance program that meets ASME NQA-1, Basic Requirements.
    d. HEGA Media Lot Acceptance Test: Testing and physical and chemical analysis of data from test performed in accordance with MIL-DTL-32101 (except Section 4.3.6.8 adsorption testing).

D. Corrosion Resistance: Provide corrosion resistance for air handling system in accordance with OBO Building Code Appendix W and OBO Mechanical Code Chapter 3.

1.6 MARKING, PACKAGING, SHIPMENT, AND STORAGE

A. Coordinate shipping to ensure all AHU components, including construction filters and inertial separator for each AHU are delivered at same time for proper field assembly or storage.

B. Packaging, shipping, and storage of filters must be done in accordance with IEST-RP-CC008 for HEGA filters, and IEST-RP-CC001 for HEPA filters. To preserve filter integrity and carbon life, ship all occupancy filters and replacement filters to arrive no earlier than 90 days before scheduled filter testing, in individual protective packaging separate from AHU housings. Ship occupancy filters so that they are on jobsite before scheduled filter testing. Carefully handle and store filters in dry location with constantly controlled temperature to protect from inadvertent construction damage. Inspect filters showing damage from shipping/handling or improper packaging to determine filter integrity; and replace damaged filters. If plastic wrapping on HEGA filters is damaged, determination will be made by Project Director/COR based upon input from OBO/PDCS/DE Mechanical Engineer as to disposition (replacement or rewrapping).

C. Each filter and filter packaging must be permanently marked in accordance with IEST-RP-CC008 for HEGA and IEST-RP-CC001 for HEPA filters. Marking must include HEGA adsorbent data (manufacturer, type, and grade), adsorbent weight, applicable warnings, and filter filled weight. Cartons or crates must be clearly marked with “This Side Up” ensure proper orientation is maintained during shipment.

D. AHU Condensate P-Trap: AHU manufacturer must ship AHU condensate P-traps with each AHU. Provide clear written instructions for proper field installation in shipment package. In extremely dry locations, trap primer may be required.

E. Contractor is responsible for submission of required documentation for export license, when such license is required, for HEGA filters to ensure HEGA filter availability in timely manner at project site for AHU commissioning.

1.7 EXTRA MATERIALS

A. Construction filters for each AHU. Prior to shipping, install one set of construction filters in each AHU, and provide additional three change-out sets of construction filters for each AHU stored in inlet plenum. Occupancy filters must not be used for initial start-up nor during construction. See Article on COMMISSIONING AND START-UP SERVICE for installation of occupancy filters.

B. Spare filters for each outdoor-air AHU. Provide four sets of primary occupancy pre-filters. Provide two sets of secondary occupancy pre-filters.

C. Spare filters for each indoor-air AHU. Provide three sets of primary occupancy pre-filters.

D. Spare gaskets for AHU access doors. Provide sufficient length of spare gasket for each size access door used on any AHU installed for project, including filter section.

E. Spare AHU Gauges. Provide one additional AHU gauge of each type and range used, including filter gauges, as spare set.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AHU: **[For Dedicated Outdoor Air Supply or Makeup Air Unit, a different manufacturer may be used for this unit than for other AHU.]**

   a. United Technologies (Carrier).
   b. Daikin Applied (McQuay).
   c. Ingersoll Rand (Trane).
   d. Johnson Controls Incorporated (York).
   e. Haakon (USA).
   f. [Desert Aire (for Dedicated Outdoor Air Supply or Makeup Air Unit only).]

2. Filter and Filter Housing:

   a. Camfil Group (formerly Camfil Farr).
   b. AAF Flanders.
   c. P&G Manufacturing.

3. Activated Carbon:

   a. Calgon Carbon Corporation.
   b. Molecular Products Group Ltd.

4. Fans (including fan arrays with gravity dampers). Use only direct drive:

   a. AcoustiFLO.
   b. Twin City Fan and Blower (Twin City Fan Companies, Ltd.).
   c. Chicago Blower Corporation.

2.2 MANUFACTURED UNITS

A. Factory design AHU components as modular sections for field assembly on concrete housekeeping pads. Size modular sections to permit installation or removal through fire egress corridors. Modular sections include:

1. Inlet plenum with modulating interconnected dampers for ventilation and return air.
2. Filter sections include pre-filter, HEPA filter, HEGA filter and post-filter.
3. Coil section includes finned cooling coils, condensate drain pans, cleaning access, plus heating coils and humidifier as required.
4. Heat Recovery Device section.
5. Fan sections, including motors and fans.

B. Casings:

1. Wall: AHU Casing must be double-wall, insulated pressure casing with no-through-wall metal joints or fasteners.
2. Joining: Bolt modular section support frame together and join modular casing sections together with leak-proof mating surfaces.
3. Base: Units must be supplied with base rails and perimeter lifting lugs for each section. Base rails must be G90 galvanized steel painted to conform to 1000-hour salt solution (5 percent) spray test without any signs of rust when tested in accordance with ASTM B117. Rust rating must be 10 with blister rating of 10 in accordance with ASTM D714. Alternatively to painted G90 steel, Type 6061 T6 welded structural aluminum may be used.
4. AHU Installed Outdoors or in Other Unconditioned Areas: Inner and outer walls must be minimum **[1.3 mm 3003 aluminum][1.6 mm (Gauge 16) 316 stainless steel]**. Associated ductwork, dampers, actuators, and other appurtenances exposed to outdoor air or mixed airstream must be 316 stainless steel or powder-coated epoxy paint. Construct roof panel to provide drainage with 5 percent maximum pitch to side.
5. AHU Installed in Conditioned Mechanical Rooms: Sheet metal wall and roof panels forming outer wall must be minimum 1.6 mm (Gauge 16) galvanized G90 steel, lock forming quality conforming to ASTM A653. Inner wall must be minimum 1.6 mm (Gauge 16) **[galvanized G90 steel, lock forming quality conforming to ASTM A653.][316 stainless steel.]** Paint outer skin to conform to 1000-hour salt solution (5 percent) spray test without any signs of rust when tested in accordance with ASTM B117. Rust rating must be 10 with blister rating in accordance with ASTM D714. **[Associated ductwork, dampers, actuators, and other appurtenances exposed to outside air or mixed airstream must be 316 stainless steel or powder-coated epoxy paint.]**
6. Deflection: AHU housing must not deflect more than L/240, where L is major axis across largest unstiffened panel.
7. Flooring: Flooring of sections must be minimum 3.2 mm (0.125 inches) thick aluminum deck tread (diamond plate), continuously welded. Structural base frame must be epoxy-painted steel C-channels.
8. Insulation: Design unit to prevent condensation on exterior surfaces. Provide calculations showing exterior surface temperatures remain above the design dew point temperature when the air handler is in cooling mode (design dew point temperature varies depending on location, indoor/outdoor, etc.). Core insulation material in walls, floor, and ceiling must be at least 50 mm (2-in.) thick UL-listed Class-1 medium-density (32 kg/cu-mtr; 2.0 lb/cu-ft) closed-cell polyurethane foam with thermal conductivity not greater than 0.024 W/m-oK (0.014 Btu/hr-ft-°F) (ASTM C518 aged R-value R-6 per inch or greater). Submit material data sheet for the selected insulation product.
9. Penetrations: Do not make penetrations of AHU casing in field; all necessary penetrations (including for coils, controls, and traps) must be made at factory.
10. Sealant Material: Joint and Seam sealant must include tapes, adhesives, masked and open weave fabric. Flange gaskets must be butyl rubber or EPDM polymer with polyisobutane plasticizer. Flange mastics must be single-component polyurethane-based, non-sag elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 12.5. Water-based joint and seam sealant must be UL723 listed, complying with NFPA for Class 1 ducts, and be resistant to UV light when cured.
11. Test Ports for Field Installation: Manufacturer must provide two test ports capable of being installed in field ductwork for sampling of airstream required during filter bypass testing.

Test ports must be cast aluminum or zinc alloy, capable of being attached over neoprene gasket and sealed with removable cap.

12. Control and Electrical Power Connections: All penetrations for control and motor electrical power connections must be performed at factory such that no additional penetrations are required to be performed in field, and to ensure that installation is leak tight.
13. Lighting: Provide one vapor-tight light fixture with globe guard and screw-in style LED bulb in each AHU service compartment that has an access door capable of personnel entry (does not apply to side access filter compartments). Provide single light switch on casing exterior to control all the lights within the AHU.

C. Filter Gauges: For each AHU, provide factory-mounted 100-mm (4-inch) dial-type Magnehelic® and transmitting differential pressure gauges with brass fittings and copper tubing to indicate pressure drop across each pre-filter, secondary filter/HEPA filter, and HEGA filter. Differential pressure gauge is not required for final filter. Gauges must be diaphragm type, with dial and pointer in metal case, black figures on white background, and equipped with vent valves and front recalibration adjustment. Calibrate gauges in SI units. Filter gauge markings must be in Pascals, with pressure range within that scheduled for maximum operating pressure of AHU. Provide placard for each filter; indicate type of filter and scheduled clean/dirty filter pressure points reflecting points in approved shop drawing submittal.

D. Condensate Pan, Drain, and Trap:

1. Condensate Pan: Install drain pan beneath cooling coils**[and humidifier]**, and extend drain pan the lesser of 800 mm downstream from face of cooling coil or entire length of coil inspection area to collect condensate. Provide removable **[galvanized steel][316 stainless steel]** floor grating over drain pan downstream of cooling coil. Drain pans must be double sloped to drain and must be continuously welded 316 stainless steel with minimum 50 mm (2 inch) depth.

2. Condensate Drain: Extend drain connection out through side of casing above structural frame of AHU; see Article on INSTALLATION. Condensate drain size must be in accordance with AHU manufacturer recommendations.
3. Condensate Trap: AHU manufacturer must provide each AHU with ASTM B88 Type L copper tube condensate P-trap with inspection caps and screw-on, electronic trap primer. Condensate trap inspection caps must be removable full-pipe-size located at top of each side of the trap; this is to facilitate inspection of water level in trap and maintenance of condensate trap and condensate drain line. P-trap must be configured for suction-side operation of sufficient depth to overcome suction pressure of supply fan with fully loaded filters without being sucked dry, plus an additional 50-mm (2-inch) mm depth.

E. Inlet Plenum Wash-down Drain: Install 40 mm floor drain with removable galvanized steel floor grating (capped for normal use) to allow unit wash down in inlet plenum; drain outlet may be located within AHU structural frame.

F. Access Doors: Access doors (not including filter section) and panels must be of same construction as wall panels. Frames must be 50 mm extruded aluminum angles with thermal break for no-through metal construction. Doors must swing 180 degrees and allow easy panel removal.

Provide finished assembly with two perimeter sealing surfaces to allow double gaskets. Provide piano or butt hinges, number and size according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible." Provide minimum of two wedge-lever-type, padlockable latches, operable from inside and outside. Doors must open against air pressure (swing out on fan suction side and swing in on fan discharge side).

G. Cooling and Heating Coils: **[ElectroFin or approved equal coils][Coils]** and fins must be airside cleanable and conform to AHRI 410 and ASHRAE 33. Thread piping connections on same end.

1. Tubes: 15 mm copper with 0.9 mm wall thickness, complying with ASTM B75M.
2. Fins: Minimum 0.23 mm (.009 inches) thick copper, mechanically bonded to tubes, with minimum fin spacing of 2.3 mm, maximum fin spacing of 3.2 mm.
3. Headers: Seamless copper with brazed joints.
4. Working Pressure Rating: 1380 kPa, test to 2070 kPa.

H. Dampers: Motorized control dampers must be opposed airfoil blade design constructed with 2 mm minimum thickness and 152 mm wide blades constructed of stainless steel, Type 304 or 316, complying with ASTM A312 or ASTM A554 equipped with replaceable seals made of either EPDM or extruded silicone. Dampers frames must be at least 2 mm thick stainless steel, Type 304 or 316, complying with ASTM A312 or ASTM A554. Secure blades 13 mm diameter zinc-plated or cast zinc axles using zinc-plated hardware, with nylon blade bearings and nylon thrust bearings at the end of each axle. Leak test each damper assembly in accordance with AMCA 500-D. Maximum air leakage must not exceed amount allowed for AMCA Class 1 rating when tested at design static pressure or 1.99 kPa, whichever is greater.

I. [Humidifiers: Comply with AHRI 640. Steam or Dispersion tube humidifiers inside AHU. Humidifiers must be stainless steel, extending entire width of AHU, with maintenance access. Locate downstream of carbon filters and heating coil. Provide stainless steel drain pan of adequate length to allow complete absorption of water vapor. Absorption distance characteristic must prevent water accumulation on any induct surfaces beyond [305][460] mm. Controls must include:

1. Disconnect switch.
2. Liquid crystal display with programmable keyboard.
3. Set point adjustment.
4. Warning signal indicating end of life of replaceable cylinder.
5. Conductivity probe for water level control.
6. High water sensor to prevent overfill.
7. Back-up float to prevent overfill with remote alarm.
8. Proof of fan before humidifier is enabled (to prevent excessive moisture from being discharged into duct whenever fan is off).
9. High/low limit relative humidity sensor.]

J. AHU Filter Housing:

1. Construct filter housing section for AHU of double-walled interior stainless steel **[316 in corrosive environment][403 in non-corrosive environment]** with single side access.

Design and construct entire filter housing to withstand negative and positive pressure of 2500 Pa and still maintain filtration leakage/bypass requirements. Continuously weld pressure retaining joints and seams with no pores allowed. Visually inspect welds for workmanship acceptance criteria described in Section 5 and 6 of ANSI/AWS D9.1. Limit filter housing size to maximum of four filters wide and three filters high. Standard filter face dimensions are nominal 609 mm wide by 609 mm high.

2. Filter housings may be designed for combination of inlet air plenum access and side access installation. The exception is that one-high filter housing configuration must be provided with only side access installation. For filter decks downstream of inlet air plenum, provide at least 0.5 meters between installed filter face and top of AHU where ductwork is installed. If no ductwork is installed through top of AHU, provide at least 0.75 meters between installed filter face and rear wall of plenum or damper (if present) for maintenance accessibility. Locate damper actuator arms (if present) so as to not interfere with filter installation.
3. Filter housing section must incorporate special securing mechanisms to retain HEPA and HEGA filters in place. Each mechanism must exert an equal force on top and bottom edge of filter sufficient for knife edge on filter section housing to penetrate filter's silicone or urethane gel sealant and maintain filter firmly in place. Interlock side access doors for HEGA filter sections with securing mechanism to prevent door closure unless filters are properly sealed in housing.
4. Filter section access doors must be swing-open type with padlock-type securing latches. Fit with reliable gasket seals to prevent leakage when closed. These side access doors must enclose HEGA and final filters; label "Warning - Do not install filters, other than construction filters, until all construction work, including drywall and painting, has ceased."
5. When HEPA and/or HEGA filter housings are installed within an AHU casing, all seams between filter housing and inner wall of AHU casing where air could potentially bypass filter section must be gasketed and sealed.
6. Factory-Installed Filter Housing Test Ports: Filter Housing Manufacturer must provide factory-installed capped test ports in filter housing upstream of HEPA filter, one in middle of each filter tier, to facilitate verification of aerosol uniformity during filter bypass testing in field.
7. Factory-Installed Filter Housing Differential Pressure Sensing Points: Male pipe thread ports must be factory welded into housings for differential pressure sensing across each pre-filter, secondary filter/HEPA filter, and HEGA filter. AHU manufacturer must attach and extend pressure tubing from ports to filter gages.
8. HEGA Test Canisters: For each filter housing incorporating ASZM-TEDA HEGA filters, install three test canisters in bypass line, and subject to same airstream as primary ASZM-TEDA HEGA filters.

K. Electric Duct Heaters: Refer to Division 23 Section on duct heaters for general requirements for electric duct heaters. Electric duct heaters must be slip-in type with gasketing on electric panel for providing tight seal on AHU casing. Heater insert frame must be capable of being connected to safing dividers within AHU casing to provide airtight connection.

L. Fixed-Plate Enthalpy Heat Exchanger: Refer to Division 23 Section on fixed-plate air-to-air energy-recovery equipment for general requirements for this equipment.

1. General: Fixed-plate enthalpy exchangers must be certified through AHRI 1060 Certification program. At nominal certified airflow, enthalpy exchanger must provide at least 60 percent total effectiveness for both heating and cooling conditions and 0 percent exhaust air transfer ratio (EATR) when tested at AHRI differential pressure between airstreams. These values must be produced from official AHRI certification data, and verification may be obtained via www.ahridirectory.org website; that website has been made available to the public by AHRI to ensure proper comparison of air to air energy recovery products.
2. Heat exchanger manufacturer must provide independent testing of enthalpy exchanger core to UL standard 900 with flame spread result less than 25 and smoke generation less than 50; these results conform to NFPA 90A and 90B for component within ducted air system.
3. Enthalpic Transfer Core: Enthalpy exchanger must provide high performance sensible and latent transfer between airstreams. This transfer must be accomplished by moving energy (both sensible and latent) molecularly through enthalpy exchanger surface while keeping airstreams physically separated. Air-to-air enthalpy exchanger must be of fixed plate type and must have no moving parts, surface-adhered desiccants, or paper parts. Core unit must be capable of both summer and winter operation with no condensation buildup or condensate management; enthalpy exchanger core must operate with no frosting or condensation at outdoor conditions above -23.3 degree C and exhaust air relative humidity below 40 percent. Infrequent incursions outside these conditions must not impact function of exchanger. Drain pans are not required.
4. Heat recovery section of AHU must be provided with galvanized steel internal bypass damper controlled by two-position, spring return actuators to be controlled by an external economizer control (refer to separate Section). This will bypass intake/outdoor air directly around enthalpic transfer core. Return/exhaust air must continue normally through cores to exhaust fan.

M. Energy Recovery Coils: Provide water coil section upstream of heating and cooling coils in outdoor-air AHU for pre-heating/cooling of outdoor air from building return/exhaust air systems. Coil construction must be in accordance with requirements above for cooling and heating coils in heat exchanger. Medium must be propylene glycol/water; ratio of those two must be in accordance with manufacturer requirement for design ambient winter temperature.

N. Heat Pipe Heat Exchangers: Provide refrigerant heat pipe heat exchanger coil section with divider partition of air stream. Coil construction must be in accordance with requirements above for cooling and heating coils in heat exchangers. Refer to Division 23 Section on heat-pipe air-to-air energy-recovery equipment.

2.3 FILTERS

A. Each filter must be tested and rated either in accordance with ASHRAE Standard 52.2.

B. Construction Filters: Construction filters must be used during construction to protect AHU and ductwork until all related project work (e.g., millwork, stone cutting, and painting) is complete in each building. A 102 mm (4 inch) deep MERV 8 filter is minimal acceptable filter for air handling unit. A 51mm (2 inch) deep MERV 6 filter is minimal acceptable filter rating for fan coil units. Dimensions of filters must be coordinated with equipment.

C. False Filter Inserts: Provide 609 mm x 609 mm x 305 mm deep metal "filter" frames with adjustable air slots that may be installed with construction filters in air handling units to simulate AHU having "clean" filters, allowing AHU to be operated thru variable speed drives without damage to drives due to high airflow/low total pressure conditions.

D. Roughing Bag-Type Pre-Filter (F-1 for MERV 11) for Single-Pass Outdoor-Air AHU: Each pre-filter must be MERV 11 bag-type filter with microfiber glass media and plastic enclosing frame. Size of pre-filter must be 609 mm x 609 mm x 559 mm deep. Initial resistance to airflow must be less than 75 Pascal at airflow of 2.5 m/s (500 fpm).

E. Outdoor-Air Pollution Control Filters (OAPCF):

1. OAPCF Particulate Filter (F-2): Outdoor-Air Particulate Filters must be minimum MERV 14 pleated polyester or polypropylene thermally glued to welded wire backing. Fiberglass media is prohibited. Media filter configuration must reduce, as shown though technical analysis, particulate contaminants (e.g., PM2.5, PM10, lead) from site microclimate air pollution sources.
2. OAPCF Molecular (Activated Carbon Gas Phase) HEGA Filter (F-3):

   a. 609 mm x 609 mm x 483 mm deep with activated carbon or other OBO/PDCS/DE/ME approved adsorption media beds that must reduce, as shown though technical analysis, gas phase contaminants from air pollution sources (VOC and local TIC) to safe level for building occupants approved by OBO/PDCS/DE Mechanical Engineer through Project Director/COR. Non-cylindrical, deep-V configuration enclosed on four sides by non-perforated case that extends full depth of beds.

   b. Activated carbon, coconut shell base, 8x16 mesh and must have a minimum carbon tetrachloride activity of 60 percent when tested in accordance with ASTM D3467; or other adsorption media in configurations that will provide required removal of gaseous contaminants.
   c. Carbon or other adsorption media in these filters must meet "base" requirements for nuclear grade media with media thickness/weight, particle size distribution, and composition selected to minimize life cycle cost. Analysis must include life cycle cost of OAPCF and of associated impact on replacement frequency of HEGA ASZM-TEDA filters.

3. OAPCF Combination Particulate and Molecular Filter (F-4): Pleated V-cell filter. Coordinate filter manufacturer's space requirements with air handler manufacturer since filter manufacturer has option of providing combination embedded particulate/molecular filters or separate particulate and molecular filters. Initial resistance to airflow of the combination particulate and molecular filter must be less than 150 Pascal at airflow of 2.5 m/s (500 fpm).
4. Filter Casing: Filter case must be high impact polystyrene capable of use in high humidity applications and must have same cross-sectional size as filter. All seams and joints that are adjacent to any portion of any filter contact surface must be ground smooth and flush with adjacent surfaces.

5. Performance: Air passing through filters must have residence time (e.g., > 0.1 sec is "typical" for activated carbon) required to remove contaminants of interest to acceptable, safe concentration levels based upon calculations performed in accordance with Appendix B of IEST-RP-CC-008 with air velocity of less than 0.25 m/sec through unbordered filter bed screen area in direction perpendicular to media. Filters must have mechanical efficiency of 99.9 percent at maximum rated flow of HEGA filter. Measure mechanical efficiency using refrigerant leak test method at maximum rated flow of adsorption filter in accordance with Section 7.3.2 of IEST-RP-CC-008.

F. HEGA Post Filter (F-5): Install MERV 8 Post Filters, sized 610 mm x 610 mm x 102 mm deep, immediately downstream of HEGA filter to capture carbon fines that may discharge from HEGA filters.

G. Pre-Filter (F-6) for Recirculating AHU: Provide MERV 13. Filter media must be microfine glass formed into mini-pleat packs and arranged into V-bank configuration with plastic enclosing frame. Size of pre-filter must be 609 mm x 609 mm x 305 mm deep. Initial resistance to airflow must be less than 85 Pascal at airflow of 2.5 m/s (500 fpm).

H. HEPA Filter (F-7):

1. Fabricate and label each HEPA Filter for AHU in accordance with IEST RP-CC001.3 for Type A performance and Grade 2 construction. Filter dimensions must be 610 mm x 610 mm x 292 mm; careful sizing based on this nominal dimension is important for filter operation. Fabricate filter pack by pleating continuous sheet of filter media per IEST RP-CC001 for Type performance and Grade 2 construction. Seal filter pack with fire-retardant solid urethane sealant.
2. Media: UL 586, fibrous glass, constructed of continuous sheets with closely spaced pleats to remove 99.97 percent of all particulate matter 0.3 microns or greater.
3. Media to Frame Side Bond: Polyurethane foam.
4. Face Gasket: Self-healing, non-flowing elastomeric gel sealant.
5. Filter Guard: Provide expanded metal grille over exposed HEPA filter material that does not interfere with filter operation.
6. Mounting Frames: Provide bolted filter-sealing mechanism to mount, and continuously seal each individual filter. Filter frame and housing must incorporate knife-edge fluid seal design that mates into highly viscous silicone gel fluid-filled perimeter channel on mounting face of filter. Grind all weld seams and joints adjacent to any portion of any gasket-sealing surface smooth and flush with adjacent metal surfaces.

I. HEGA ASZM-TEDA Molecular Filter (F-8):

1. Each HEGA molecular filter must be 610 mm x 610 mm x 483 mm deep, with activated carbon beds in deep-V configuration enclosed on four sides by non-perforated case that extends full depth of beds.
2. Adsorption filters must consist of multiple flat adsorbent beds in V-cell configuration, with minimum bed depth of 25 mm of activated carbon impregnated with ASZM-TEDA in accordance with specification MIL-DTL-32101. Bind carbon media in each bed with two perforated sheets spaced uniformly apart. To prevent air bypassing sides of beds, seal internal sides of case to ends of beds with adhesive or sealant in accordance with section

4.4.2 of IEST-RP-CC008 and provide each perforated sheet with minimum of 12 mm solid margin around all four sides. Line each perforated sheet with durable scrim to prevent carbon granules from passing through larger holes in perforated sheet. Activated carbon must be 12x30 mesh, specially impregnated coal base, carbon conforming to MIL-DTL-32101.

3. Filter Casing: 3.2-mm thick, non-perforated high impact polystyrene capable of incineration. Overall case dimensional tolerances must conform to IEST-RP-CC008, Section 6.4.4. Filter case and housing must incorporate knife-edge fluid seal design that mates into silicone or urethane gel fluid-filled perimeter channel on mounting face of filter. Grind all seams and joints adjacent to any portion of any gasket-sealing surface smooth and flush with adjacent metal surfaces.
4. Performance: Air passing through filters must have residence time of 0.1 seconds or greater based upon calculations performed in accordance with Appendix B of IEST-RP-CC-008 with air velocity of less than 0.25 m/sec through un-bordered filter bed screen area in direction perpendicular to media. Filters must have mechanical efficiency of 99.9 percent at maximum rated flow of HEGA filter that maintains the residence time of 0.1 seconds at bed velocity of less than or equal to 0.25 m/sec. Measure mechanical efficiency using refrigerant leak test method at maximum rated flow of adsorption filter in accordance with Section 7.3.2 of IEST-RP-CC-008.
5. Requirements for Chemical Agent Gas Life Test identified in MIL-DTL-32101, Section 4.3.6.8 are not required. However, provide manufacturer's test data for each lot; see Article on SUBMITTALS.
6. Pressure Drop: Average pressure drop across filter must be no more than 490 Pascals at maximum allowable airflow through filter that still provides required minimum residence time of 0.1 seconds at bed velocity of less than or equal to 0.25 m/sec. When tested at filter's rated airflow, pressure drop across each filter in lot must vary by no more than 10 percent of arithmetic mean of pressure drops across all filters in lot.

J. HEGA Filter Test Canisters (F-9): Three removable, replaceable, adsorption media ASZM-TEDA activated carbon sampling devices on each AHU, with same maximum velocity and residence time characteristics as rest of adsorption filter. Sampling media canisters must be approximately 50 mm diameter, and either accessible from filter housing frame door or externally mounted and accessible from filter housing. Provide equal number of canister blanks to prevent air bypass when sampling media canisters are removed for testing.

2.4 OUTDOOR AIR INLET

A. Provide weather protection hood. Hood must be Type 316 stainless steel complying with ASTM A554.

B. Bird Screen: Corrosion-resistant 6 mm galvanized mesh bird screen that conforms to ASHRAE 62.1/62.2.

C. [Inertial Separator: Design and provide AHU with inertial separator, installed upstream of the AHU, to extend life of particulate filters by separating heavy airborne particles as air changes direction. Depending on equipment size, use a fan to either supply air through

inertial separator with 10 percent exhaust bleed air, or exhaust 10 percent bleed air of sand and heavy particles from inertial separator.]

2.5 MOTORS AND VARIABLE FREQUENCY DRIVES

A. Motors must be totally enclosed fan-cooled (TEFC) rated as premium efficiency with Class H insulation and service factor of 1.15. Conventional efficiency tests must be performed in accordance with NEMA MG 1.

B. Design and rate motors for use with variable frequency drive controllers suitable for use throughout entire speed range without overheating. Comply with NEMA MG 1 for thermal overload protection. Use electronic filters conforming to IEEE 519 for power supply. Provide remote monitor leads compatible with energy management system. Refer to Division 23 Section on motor requirements for HVAC equipment and Division 26 Section on variable frequency motor controllers for additional requirements.

C. All motor wiring must be factory installed, with leak tight penetration through AHU fan housing section. Install all necessary conduit penetrations at factory for fan, coil, and return/outdoor-air plenum to accommodate field installation of BAS wiring; penetrations must be capped internally and externally for testing.

D. Provide continuous current, voltage, and power monitoring at each AHU variable frequency drive, together with data logger for historical data retrieval.

2.6 FANS

A. Fan section must be factory fabricated, assembled, tested. Equip with direct drive centrifugal plenum fan, motor, disconnect switch, drive assembly, and housing.

B. Comply with AMCA 99 for operating limits. Factory tests must conform to AMCA 210 for fan performance data. Comply with AMCA 300 and AMCA 301 for acoustical data.

C. Fan wheel must be aluminum, and employ backward inclined blades that are welded or riveted to flange and back plate.

D. Static and dynamic balances must conform to ISO 14694. Motor vibration must conform to NEMA MG 1 Part 7 “Motor and Generators.”

E. Fan shaft must be turned, ground polished, hot rolled steel with keyway, designed to operate at no more than 70 percent of first critical speed when rotating at top of fan speed range.

F. Center fan inlet in fan wall for optimal airflow characteristics and condensation control.

G. Provide piezometer ring with digital display indicating airflow accurate to within plus/minus 5 percent.

H. Provide fan section door electrical interlock that prevents fan operation when door is open.

I. Service disconnect must be provided by the AHU manufacturer and mounted both within sight and 2 meters reach of motor access door.

J. Labels: On fan door assembly, mount placard with designation of unit, design airflow rate in L/s and M3/hr, and design pressure drop of AHU in Pascals.

K. Fan/Motor Assembly Mounting: Mount assembly structural steel frame such that fan inlet is centered over cooling coil to promote even airflow over coil surface area. Mount fan assembly on steel frame or fan floor casing as applicable, or on seismic or vibration isolators as applicable for site seismicity requirements, and anchored to section floor casing or fan mounting frame as applicable. Refer to Division 23 Section on vibration and seismic controls for HVAC.

2.7 FILTER GAUGES

A. For each filter on air handling unit, except for final filters after HEGA filter, provide factory-mounted 100 mm dial-type Magnehelic® and transmitting differential pressure gauges with brass fittings and pneumatic tubing for inside AHU and copper tubing where exposed outside of AHU or Filter Housing. Gauges must be diaphragm type with dial and pointer in metal case, with black figures on white background, and with vent valves and front recalibration adjustment. Calibrate gauges in Pascals. Gauge range must be between 0-750 Pascals for pre-filters and 0-500 Pascals for HEPA and HEGA filters. Manufacturer must provide placard beneath each gauge indicating the type filter gauged, design “clean” and “dirty” filter pressure drops in Pascals for AHU design airflow (pressure drop for maximum airflow allowed for filters at maximum filter airflow capability allowed is not acceptable).

2.8 ACCESSORIES

A. Provide foot-pedal operated hydraulic scissor lift table on push truck cart equipped with caster wheels and brakes capable of lifting and lowering HEGA filters to/from AHU filter housings.

1. Minimum Lifting Capacity: 350 kg
2. Lifting Height: 1.5 meters
3. Width x Length: 61 cm x 122 cm

2.9 FACTORY ACCEPTANCE TESTING

A. General:

1. Notify Project Director/COR of testing date and location at least 45 days in advance of testing to facilitate OBO/PDCS/DE/ME representative to witness testing and beginning of start-up service.
2. Facilitate access by OBO/PDCS/DE/ME representative to place where air-handling units are being tested for witness testing.
3. Fabrication must be fully completed and ready prior to witness testing.
4. Successful witness testing is a required quality assurance procedure prior to shipping of air-handling units.

B. HEGA Media Lot Acceptance Test: Analyze physical and chemical characteristics in accordance with applicable standard (e.g., ASTM D 3467).

C. Filter Housing Test: Housing manufacturer must test housings for filter alignment, filter fit, and for clamping mechanism operation. Leak test filter sealing surfaces and filter housing assembly pressure boundary in accordance with Section TA of ASME AG-1 before leaving factory. Record pressure readings once per minute for five minutes. Maximum leak rate must not exceed 0.008 liter/second per cubic meter of filter housing volume.

D. AHU Casing Pressure Test:

1. Assemble, install, and fill condensate drain trap with potable water prior to conducting AHU Casing Pressure Test.
2. After test preparation is completed, conduct pressure test in accordance with ANSI/AHRI 1350.
3. Leakage Test: Conduct test at design static pressure or 2.48 kPa (positive in normally positive pressure areas, negative in normally negative pressure areas), whichever is greater. Air leakage for AHU, including coil and wiring penetrations, must not exceed 1.0 percent of total design airflow.
4. Deflection Test: Air handling unit housing must not deflect more than L/240 during any part of air handling unit and filter section pressurization tests, where L is major axis across largest unstiffened section of air handling unit parallel to direction of airflow between filter housing and fan. OBO/PDCS/DE Mechanical Engineer or their designee must be present for test and will select one unit per factory visit for deflection test. If chosen unit fails to meet deflection test requirements, all remaining AHU must also be tested. If unit fails to meet test requirements, corrections must be made at Contractor's expense.

PART 3 - EXECUTION

3.1 FIELD EXAMINATION

A. Examine concrete pads for compliance with requirements for installation tolerances and other conditions affecting installation and performance of HVAC casings. Verify sufficient height exists to allow proper mounting of provided P-trap without contacting the floor.

B. Examine roughing-in of hydronic drainage piping systems and electrical services to verify actual locations of connections before installation.

C. For renovation and system replacement projects, verify that roof structure can handle load.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Concrete Bases: Install floor mounting units with sufficient height to ensure clearance for condensate trap installation above finished floor, with minimum of 100 mm high concrete bases.

See Division 23 Section on common work results for HVAC for concrete base materials and fabrication requirements.

B. **[Rooftop units: Mount rooftop units on 1000 mm high structural railing to allow for roof maintenance under the AHU. Include raised platform with railing around perimeter of rooftop unit to facilitate AHU maintenance.]**

C. Units with Internally Isolated Fans: Secure units to anchor bolts installed in concrete bases. Remove manufacturer's shipping retainers on the internal isolators supporting fan mounting frame and adjust per manufacturer's recommendations.

D. Install weather protection hood over the outdoor-air inlet. **[Bottom of weather hood must be a minimum of [XX mm] above roof to preclude impedance of airflow by snow accumulation and its resulting interference of system performance. Include heat trace on outdoor-air damper.]**

3.3 CONNECTIONS

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems.

B. Piping installation requirements are specified in other Division 23 Sections. Construction Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to AHU to provide coil pull space, and to facilitate service and maintenance.

C. Drain Piping:

1. Condensate Drains: Install factory provided condensate trap to drain pan outlet with inlet and outlet connection locations in accordance with manufacturer's drawings. Connect condensate drain piping using hard copper tube, ASTM B88, Type **L [cast-][or][wrought-]copper [solder-joint][or][pressure-seal joint]** fittings; and **[brazed][or][soldered][or][pressure-seal]** joints. Extend to nearest equipment or floor drain. Install cleanouts at each change in direction. Install electronic trap primer system within condensate drain trap inlet above water line to prevent P-trap from drying out. Plastic "P" traps are prohibited.
2. Wash-Down Drain: Connect 40 mm Type L copper drain pipe with ball valve to drain outlet connection and route separate from condensate drain pipe to nearest equipment or floor drain.

D. Connect hot and chilled water piping to supply and return coil taps, with shutoff or balancing valve and union or flange at each connection. Hangers and supports must support piping so that no piping is supported by air handling unit.

E. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in duct and duct accessory Specifications. Make final duct connections with flexible connections.

F. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls. Ground equipment according to Division 26 Section on grounding and bonding for electrical systems. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. Service disconnect, provided by AHU manufacturer, must be mounted both within sight of, and 2-meters reach of, fan motor access door. **[Use NEMA enclosure type 4X panels in locations where exposed to outdoor air or unconditioned outdoor airstream.][Use stainless steel wire connectors in outdoor locations.]**

G. Install HEGA filter sampling canister assemblies in accordance with manufacturer's installation requirements.

H. Injection and sampling ports: Locate on ductwork so that ports are easily accessible by maintenance personnel on upstream and downstream side of filter housing for commissioning and subsequent testing of HEPA/HEGA performance in accordance with Section TA of ASME AG-1. Locate injection ports in ductwork upstream of filter section to allow even distribution of test agent (e.g., poly-alpha-olefin (PAO), R-11) across entire filter area. Locate downstream sampling ports after fan discharge in area of ductwork that is accessible. Add warning labels to prevent damage to unit.

I. Verify pressure gauges and air flow monitor pneumatic tubing are connected to the device and gauges. Ensure proper calibration of pressure gauges and airflow monitor. Verify that all equipment labels are installed on the AHU.

J. [If site conditions require incorporation of inertial separator on an outdoor-air intake, verify that system has been installed in accordance with manufacturer's instructions and that bleed exhaust fan is operable.]

3.4 FIELD QUALITY CONTROL

A. After equipment/system installation, perform the following field tests and inspections:

1. Condensate Trap Leakage: Fill condensate trap with potable water. Verify that AHU condensate traps maintain seal with potable water at maximum design static pressure to prevent air from entering AHU through the condensate drain line.
2. AHU Casing Pressure Test: Modular AHU assembled in field must be tested again in accordance with procedure described in Article on FACTORY ACCEPTANCE TESTING.
3. Filter Bypass Test: Commissioning and subsequent testing of HEPA and adsorption filter performance must be in accordance with Section TA of ASME AG-1. Independent test agent must identify appropriate locations in ducts for test ports provided for field installation described in Article on MANUFACTURED UNITS, and must install identified test ports in those locations. After installation, permanently mark location of these test ports. If halide gas detection instrument is gas chromatograph (GC), test must include at least four readings taken at least one minute apart within ten-minute interval at rated flow. If halide gas detection instruments are detectors, detectors must continuously monitor real time of "pulse" charge of halide gas at rated flow, and plot levels using printer provided by

testing agent for inclusion with test reports. Reading may not exceed 0.1 percent of upstream value for R-11 (gas) or 0.03 percent of upstream value for particles.

B. Final field assembly must be tested as complete integral AHU and certified to meet rigid life safety requirements of enhanced filtration.

C. Demonstrate to post Facility Manager and Project Director/COR proper operation of AHU and controls.

3.5 COMMISSIONING AND START-UP SERVICE

A. Factory-trained technician must inspect field-assembled components and equipment installation, including piping and electrical connections, and perform start-up and performance testing service in accordance with this Article and AHU manufacturer's recommendations.

B. Prior to AHU startup, perform the following minimum tasks:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that spring isolators are installed and adjusted.
3. Verify that unit is secure on mountings and supporting devices.
4. Verify that connections to piping, ducts, and electrical systems are complete.
5. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
7. Lubricate bearings and other moving parts with factory-recommended lubricants.
8. Set connected duct system variable air terminal dampers to fully open position.
9. Set outdoor-and return-air mixing dampers to minimum outdoor-air and maximum return air settings.
10. Clean packaged air-handling units internally upon completion of installation according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum-clean fan wheels, cabinets, and coils entering air face.
11. Comb coil fins for parallel orientation.
12. Coil leak test. Fill water coils with water. Test coils and connections for leaks. Repair leaks and retest until no leaks exist. Drain coils and fill with water or water and propylene glycol solution.

C. Startup: Perform the following minimum tasks:

1. Filters. Verify installation of construction filters.
2. Fans. Verify proper motor rotation direction and verify free fan wheel rotation and smooth bearing operations. After electrical circuitry has been energized, start units to confirm proper motor rotation and drive unit operation. Run fan through entire operational range using VFD controls to verify proper installation. Remove malfunctioning motors, replace with new units, and retest. Adjust fan drive to scheduled RPM for initiation of system balancing. Measure and record motor electrical values for voltage and amperage.

3. Dampers. Adjust damper linkages for proper damper operation. Manually operate dampers from fully closed to fully open position and record fan performance. Refer to Section 250593 “Testing, Adjusting, and Balancing for HVAC” for packaged air-handling system testing, adjusting, and balancing.
4. Separators. Test inertial separators per the general requirements outlined in ISO 5011.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. After Successful Startup: Perform the following minimum tasks after AHU testing, welding, gypsum board installation, sanding, painting, and other dust- and/or VOC-generating activities have been performed and after all spaces are clean of construction dust and fumes, perform the following:

1. Remove construction filters.
2. Clean filter housings.
3. Install occupancy filters.
4. Perform testing, adjusting, and balancing of packaged air-handling and air-distribution system.
5. Commission air-handling and air-distribution system.

3.6 DEMONSTRATION

A. Factory-trained technician (on equipment being installed) must train post’s maintenance personnel to adjust, operate, and maintain packaged AHU.

END OF SECTION 237315

SECTION 260508 – COMMON WORK RESULTS FOR ELECTRICAL, COMMUNICATIONS AND ELECTRONIC SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Supporting devices for electrical components.
2. Electricity-metering components.
3. Sleeves and sleeve seals.
4. Lock-out/tag-out devices.
5. Safety accessories.
6. Safety considerations for outdoor substations.
7. Concrete equipment bases.
8. Underground cable connections.
9. Touchup painting.

B. Related Sections include the following:

1. Section 260573 “Overcurrent Protective Device Coordination Study” for arc flash study.
2. Section 337105 “Underground Ducts and Raceways.”

1.2 SUBMITTALS

A. Shop Drawings: Show location of underground cable splices, including associated manhole or handhole.

B. Product Data: For each type of product indicated, including lock-out/tag-out devices and safety accessories.

C. Operational Procedures:

1. Identify procedures for equipment isolation, energizing, and de-energizing.
2. Identify procedures for use of Lock-Out/Tag-Out devices and use of safety accessories.

D. Lock-Out/Tag-Out (LOTO) Device Schedule: Identify which LOTO model is intended to be used for each applicable electrical equipment.

1.3 SYSTEM CHARACTERISTICS

A. Facility Voltages: These characteristics apply to work of all Sections for this project.

1. [Medium Voltage: In accordance with Host Country utility voltage.]

a. [50] [60] Hz.
b. [Δ] [Y].]

2. Site Distribution Voltage:

a. Three-phase.
b. **[New Construction: [400/230][208/120][480/277][600] volts.]**
c. **[Existing Facilities: [380/220][400/230][208/120][480/277][600] volts.]**
d. **[50] [60]** Hz.
e. **[Δ] [Y].**

3. Utility Voltage:

a. Single-phase.
b. **[120][220]** volts.
c. **[50][60]** Hz.

4. Control Voltage: In accordance with voltage for associated controlled equipment.

1.4 CORROSION PROTECTION

A. Corrosion protection shall conform to OBO Electrical Code Chapter 1 and OBO Building Code Appendix W.

B. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

1.5 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.6 COORDINATION

A. Coordinate arrangement, mounting and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

D. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 08 Section on access doors and frames.

F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

G. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

H. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS

2.1 OUTDOOR SUBSTATIONS

A. Metal Enclosures: Use metal enclosures around all live parts.

B. Locks: Provide on gates with key interlocks on switchgear doors to prevent access to live parts.

C. Clearances: Conform to clearance requirements in the OBO Electrical Code and National Electrical Safety Code (ANSI C.2).

2.2 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to Project Director/COR.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 14-mm-diameter slotted holes at a maximum of 50 mm o.c., in webs.

D. Slotted-Steel Channel Supports: Comply with Metal Framing Manufacturers Association MFMA-4 and Division 05 Section on metal fabrications for slotted channel framing.

1. Channel Thickness: Selected to suit structural loading.
2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 14-mm- diameter holes at a maximum of 200 mm o.c., in at least one surface.

1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
2. Rated strength: Selected to suit specified load criteria

F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.

J. Powder-Driven Threaded Studs: Heat-treated steel.

2.3 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING.

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

C. [Modular Meter Centers: Factory-coordinated assembly of a main meter center circuit-breaker unit with wireways, tenant meter socket modules, and tenant branch circuit breakers arranged in adjacent vertical sections, complete with interconnecting buses.

1. Housing: NEMA 250, Type 3R enclosure.]

2.4 [EQUIPMENT FOR ELECTRICITY METERING FOR GOVERNMENT USE

A. [Meter: Electronic kilowatt-hour measuring to record electricity used.]

B. [Meter: Electronic kilowatt-hour/demand measuring to record electricity used and highest peak demand over a time period according to electric utility. Meter is designed for use on the type and rating of circuit indicated for its application.]

1. Kilowatt-Hour Display: Digital liquid crystal.
2. Kilowatt-Demand Display: Digital, liquid-crystal type to register highest peak demand.
3. Enclosure: NEMA 250, Type 1, minimum, with hasp for padlocking or sealing.
4. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
5. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for the ratings of the circuits indicated for this application.
6. Type: Solid core.
7. Accuracy: Nationally recognized testing laboratory certified to meet ANSI C12.16 specifications.
8. Demand Signal Communication Interface: Match signal to building automation system input that conveys data on instantaneous/integrated demand level measured by meter used for load switching to control demand.

C. Current-Transformer Cabinets: Listed or recommended by metering equipment manufacturer for use with sensors indicated.]

2.5 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 1.3- or 3.5-mm (0.05- or 0.14-inch) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section on penetration firestopping.

2.6 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: **[EPDM][NBR]** interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 LOCK-OUT/TAG-OUT (LOTO) DEVICES

A. Provide lockout tag-out devices to securely de-energize equipment in the Sections identified below. A set of LOTO devices shall be selected by the Contractor to positively lock-out all of the models of equipment in these Sections. Provide five of each model of LOTO device for each model of LOTO device in the set.

1. Division 26 Section on secondary unit substations.
2. Section 261214 “Medium-Voltage Transformers.”
3. Division 26 Section on medium voltage switchgear.
4. Section 262300 “Low-Voltage Switchgear.”
5. Section 262313“Paralleling Switchgear.”
6. Section 262315 “Double-Ended Switchgear.”
7. Section 262325 “Power Sequence of Operation.”
8. Section 262412 “Switchboards.”
9. Section 262417 “Panelboards.”
10. Division 26 Section on motor-control centers.
11. Section 262500 “Enclosed Bus Assemblies.”
12. Division 26 Section on fused power circuit devices.

13. Division 26 Section on enclosed switches and circuit breakers.
14. Division 26 Section on enclosed controllers.
15. Division 26 Section on variable frequency motor controllers.
16. Section 263214 “Engine Generators.”
17. Section 263237 “Resistive Load Banks.”
18. Section 263535 “Power Factor Correction Equipment.”
19. **[Section 263552 “Low-Voltage Automatic Voltage Regulators.”]**
20. **[Section 263554 “Medium-Voltage Automatic Voltage Regulators.”]**
21. Section 263600 “Transfer Switches.”

2.8 SAFETY ACCESSORIES

A. Supply safety accessories identified below to assist in safely de-energizing AVR and transformer. Provide prior to system and testing and commissioning.

1. Two live–line tools conforming to ASTM F711; one 1200 mm (4 foot) and one 1800 mm (6 foot) in length.
2. Non-contact voltage proximity detector. Detector shall have both audio and visual alerts and warning indicators. Detector shall be instrument rated for AVR and transformer voltages. Detector shall be compatible with live-line tool.
3. Two pair voltage-rated (VR) gloves and leather protectors conforming to ASTM D120 Class 2 (voltage rating of 17,000 AC and 25,500 DC); one pair glove size 8.5, and one pair glove size 9.5. Provide canvas bags for glove storage.
4. Two sets VR rubber sleeves similar voltage rating as VR gloves, with canvas storage bags.
5. Two arc flash protection suits, conforming to ASTM F1506, and rated for NFPA 70E hazard class 4 (40 cal); one sized large and one sized medium.
6. Two sets safety grounds capacity rated for application conforming to ASTM F855. Ground cluster connectors shall acceptably secure clamp onto phase conductor and ground conductor.
7. Retrieval stick conforming to ASTM F711; 1800 mm (6 foot) in length.

2.9 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified in Section 033000 "Cast-in-Place Concrete."

B. Concrete: As required for footings/foundations in Section 033000 "Cast-in-Place Concrete."

2.10 TOUCH-UP PAINT

A. Equipment Not Exposed to Harsh Environment: Equipment manufacturer's paint.

B. Equipment Enclosures Not Exposed to Harsh Environment: Manufacturer's standard finish for indoor installations in non-harsh environments.

C. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

D. Paints for Applications Exposed to Harsh Environments: For all outdoor applications and for indoor applications in harsh environment refer to Division 09 Section on high performance coatings. Metallic materials shall be protected against corrosion.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

F. Electrical equipment shall be designed and rated to operate in project-specific unusual environmental conditions such as wind-blown sand, salt atmosphere, flooding, ultraviolet rays due to altitude, high winds such as hurricanes and tornadoes, etc. Where standard ratings are not available to match environmental conditions, equipment shall be derated as required to compensate for factors such as high altitude and ambient temperature. Equipment installed in conditioned spaces shall be designed and rated for the conditioned ambient.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 90-kg design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 6-mm diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 40-mm and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 600 mm from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. **[Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.]**
3. New Concrete: Concrete inserts with machine screws and bolts.
4. **[Existing Concrete: Expansion bolts.]**
5. **[Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.]**
6. Steel: Welded threaded studs or spring-tension clamps on steel.
7. Field Welding: Comply with AWS D1.1.
8. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
9. Light Steel: Sheet-metal screws.
10. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.1 UNDERGROUND CABLE CONNECTIONS

A. Minimize underground cable splices.

1. Splices that are made shall be made cables inside manholes or handholes. See Division 33 Section on underground ducts and raceways for manholes and handholes.
2. Provide identification for manholes and handholes that contain splices.
3. Underground cable splices shall be made using UL-approved methods for water-exposed direct burial locations.
4. To the extent readily feasible, cable splices shall be located 300 mm (12 inches) above highest water mark inside manholes or 300 mm (12 inches) above known water table.

3.2 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.3 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 07 Section on penetration firestopping.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 100 mm (4 inches) larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated.

1. Refer to Section 271116 “Communications Cabinets and Frames” regarding constraints on usage at telecommunications equipment.

3.5 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Supporting devices for electrical components.
2. Electricity-metering components.
3. Cable splices.
4. Concrete bases.
5. Cable splices.
6. Touchup painting.
7. Sleeves and Seals

B. Test the Government's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.
2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.
3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.
5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.6 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 painting sections.

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 DEMONSTRATION

A. Demonstrate, to Project Director/COR and appropriate post electrical staff, the operation of each lock-out/tag-out (LOTO) model and safety accessories. Identify which LOTO model is used for each applicable electrical equipment, referencing LOTO Schedule. Coordinate with training in Section 260573 "Overcurrent Protective Device Coordination Study." Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 260508

SECTION 260518 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. Related Sections include the following:

1. Division 07 Section on “Penetration Firestopping.”
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
3. Division Section 26 on “Identification for Electrical Systems.”
4. Division 27 Sections for communications cables.
5. Section 337105 "Underground Ducts and Raceways."

1.2 SUBMITTALS

A. Product Data - General: For each type of product indicated.

B. Product Data - Products Manufactured to International Standards: Identify variations from U.S. standards.

C. Qualification Data: For testing agency.

D. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association (NETA), or is nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Article on FIELD QUALITY CONTROL.

B. Comply with the OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NFPA 70, Article 100 by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

C. Products Manufactured to International Standards: Variations from U.S. standards require evaluation and approval by Project Director/COR with input from OBO/PDCS/DE/EE.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductor Material: Copper only complying with NEMA WC 70; solid conductor for 6.0 mm2 and smaller, stranded for 10.0 mm2 and larger.

B. Conductor Insulation Types: Type THHN-THWN, XHHW, SO, or XHHW-2 complying with NEMA WC 70

1. International Type Conductors and Cables: If requests are approved for international type conductors and cables, conductor and cable ampacities for applications of 600-VAC or less shall not exceed ampacities listed in National Electrical Code Table 310.16.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type XHHW or XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

H. Underground Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

J. Fire Alarm Circuits: Type THHN-THWN, in raceway.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

M. Class 3 Control Circuits: Type THHN-THWN, in raceway.

N. Control wiring shall be minimum of 2.5 mm2 (#14 AWG) stranded copper and shall be rated for 600-volt service.

O. Neutral Conductor: Where a secondary distribution system requires a neutral conductor, a full-sized neutral conductor shall be used throughout the system, such that neutral conductor is not shared with any other branch circuit or feeder. If the secondary distribution system supports computers or other equipment that generates harmonics, double size neutrals shall be run from the subpanel boards feeding this equipment back to the MDP or service entrance. Neutral buses shall be sized to accommodate these conductors.

P. Ground Conductor: Insulated equipment grounding conductors run with branch circuits shall be installed such that that conductor is not shared with any other branch circuit.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety."

F. Seal around cables penetrating fire-rated elements according to Division 07 Section on "Penetration Firestopping."

G. Identify and color-code conductors and cables according to Division 26 Section on “Identification for Electrical Systems.”

H. Install outdoor underground feeders in concrete encased ductbank in accordance with Section 337105 “Underground Ducts and Raceways.”

I. Each electronic equipment rack shall be fed by an individual circuit breaker protected branch circuit.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 300 mm of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification (ATS), Section 7.3. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260518

SECTION 260525 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:

1. Section 076205 “Sheet Metal Flashing and Trim.”
2. Section 263105 “Solar Photovoltaic Systems.”
3. Section 264115 “Lightning Protection System.”
4. Section 270526 “Grounding and Bonding for Communications Systems.”
5. Section 331416 “Site Water Distribution Piping” for water service and water meter piping.
6. Section 337105 "Underground Ducts and Raceways" for ground test wells.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Article on FIELD QUALITY CONTROL, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency’s field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: Include the following in operation and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.

   a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
   b. Include recommended testing intervals.

1.3 QUALITY ASSURANCE

A. Grounding & Lightning Protection System. The system shall meet the requirements as listed on the plan drawings for UL 96.

B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association (NETA) and that is acceptable to Project Director based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA to supervise on-site testing specified in Article on FIELD QUALITY CONTROL.

C. Comply with UL 467.

D. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

E. For overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

F. Comply with NFPA 780 “ Standard for the Installation of Lightning Protection Systems.”

G. Comply with UL 96 when interconnecting with lightning protection system; see Section 264115 “Lightning Protection System.”

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. For insulated copper conductors, comply with Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

D. Grounding Electrode Conductors: Stranded copper cable.

E. Underground Conductors: Bare copper, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors:

1. Bonding Cable (interconnecting ground rods): copper conductor.
2. Bonding Conductor/Jumper: stranded copper conductors, sized per the National Electrical Code.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section 6 x 50 mm, with insulators as shown on drawings.

2.2 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

B. Ground Rods

1. Size: 20 mm diameter by 3000 mm long.

C. Test Wells: Provide handholes as specified in Section 337105 "Underground Ducts and Raceways."

PART 3 - EXECUTION

3.1 APPLICATION

A. In raceways, use insulated equipment-grounding conductors.

B. Connections: Connections shall be made by one of the following methods:

1. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
2. Irreversible Mechanical Connections (IMC): Use for any connections. Mechanical connection shall be made by specialized tool for irreversible mechanical connections which shall apply permanent marking to connector to identify that connection was made.

C. Equipment Grounding Conductor Terminations: Exothermic or irreversible Mechanical connection.

D. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

E. Grounding Bus: Install in electrical room and in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 25 mm from wall and support from wall 150 mm above finished floor, unless otherwise indicated.
2. At doors, route the bus up to the top of the doorframe, across the top of the doorway, and down to the specified height above the floor.

F. Underground Grounding Conductors: Use bare-copper conductor, 95 mm^2 minimum. Bury at least 450 mm below grade or bury 300 mm above duct bank when installed as part of the duct bank.

G. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors or IMC, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with Article 250 of the OBO Electrical Code for types, sizes, and quantities of equipment grounding conductors, unless more restrictive specific types, larger sizes, or more conductors are indicated on Drawings.

B. Install equipment grounding conductors in all feeders and circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by the OBO Electrical Code:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. X-Ray equipment circuits
9. Computer outlet circuits

D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for communications cables.

H. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 220 V or higher, including air cleaners and heaters. Bond conductor to each unit and to air duct.

I. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

J. Signal and Communication Systems: For alarm, voice, data, and other communication systems, provide insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, telecommunications rooms, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 6.0 mm thick by 50 mm high by 300 mm long grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding bus bar/terminal.

K. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

L. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized the same as power system grounding electrode conductor, and install in conduit. See Section 264115 “Lightning Protection System.”

M. Photovoltaic Systems: For system grounding connection, use of fine stranded grounding conductor is not permitted; refer to Section 263105 “Solar Photovoltaic Systems.”

3.3 COUNTERPOISE

A. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 18 m apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than 95 mm^2 for counterpoise and for tap to building steel. Bury counterpoise not less than 450 mm below grade and 600 mm from building foundation.

3.4 INSTALLATION

A. Ground Rods: **[Install ground rods as indicated on the drawings.] [Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.]**

1. Drive ground rods until tops are 300 mm below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors or IMC for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building; see Section 331416 “Site Water Distribution Piping.” Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors. See Section 331416 “Site Water Distribution Piping.”

F. Bond roof metal materials to equipment grounding conductors or lightning protection system; see Section 076205 “Sheet Metal Flashing and Trim.”

G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

H. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

I. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.

J. [Under Ground (Concrete-Encased Grounding Electrode): Fabricate according to the OBO Electrical Code using a minimum of 6.0 m of bare copper conductor not smaller than 25 mm2. If concrete foundation is less than 6.0 m long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.]

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with bi-metal stainless-steel separators and mechanical clamps approved for application.
4. Make aluminum-to-galvanized steel connections with bi-metal tin-plated copper jumpers and mechanical clamps approved for application.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surface indicating improper cleaning are not acceptable.

C. Irreversible Mechanical Connection (IMC): Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make visible indication that each connector has been adequately compressed on grounding conductor.

D. Equipment Grounding Conductor Terminations: For 10 mm^2 and larger, use pressure-type grounding lugs. 10 mm^2 and smaller grounding conductors may be terminated with winged pressure-type connectors.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

G. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Duct Banks: Install grounding conductor with at least 50 percent ampacity of largest phase conductor in duct bank. See Section 337105 "Underground Ducts and Raceways."

B. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 100 mm will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a 70 mm^2 bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 50 mm above to 150 mm below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 25 mm^2 minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than 35 mm^2 for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 600 mm below grade and 150 mm from the foundation.

3.7 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

B. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each building electric service entrance, electric/telecom rooms, generator system, buildings and lightning protection system where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Tests at each ground rod before any conductors are connected are not required if a clamp-on ground tester is used. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being

moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Maximum value of acceptable system ground resistance is 10 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, drive additional ground rods until resistance meets specified values.

END OF SECTION 260525

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes three computer-based fault-current, overcurrent protective device coordination, and arc flash studies to determine suitability of, and settings for, overcurrent protective devices, and identification of proper personal protective equipment to be used when maintaining the studied electrical system.

B. Purpose of this overall study is to facilitate:

1. Identification of Amp Interrupting Capacity (AIC) to prevent equipment damage.
2. Identification of personal protective equipment to minimize effects of arc flash at specific device locations.
3. Improvement of system reliability and isolation of faults.

C. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety,” including lock-out/tag-out devices and other electrical safety accessories.
2. Division 23 and 26 Sections requiring personnel protection in accordance with NFPA 70E.

1.2 SUBMITTALS

A. Software Information and Data Files - General:

1. Provide technical data information describing for operating system, study software capabilities and features, applicable standards, operator interface, color graphics. Include associated third-party applications.
2. After final version of Study is performed and accepted, provide data files which contain all required information to reconstruct study and allow system modification in future when used with application software. This electronic file shall include all library type data such as that for circuit breaker curves used on this project, as well as data which represents all physical and electrical characteristics of power system that Contractor had to provide for complete and proper study. This data is likely only compatible with particular software application used to generate study.

B. Software Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399. For arc-flash study program, certifying compliance with IEEE 1584.

C. Qualification Data: Coordination-Study Specialist and Testing Agency.

D. Overall Study and Report Requirements – General:

1. Results of each of the three studies shall be summarized at the start of each subsection in the overall report. Each subsection shall have an executive summary, description, purpose, basis, and scope of each study
2. Submit searchable PDF versions of this Study for review during construction. Deliver five bound hardcopies of complete final report to the post Facilities Staff along with three copies on CD/DVD.
3. Reports, diagrams, and in field equipment shall follow naming conventions and contract drawings at all locations.
4. Single Line Diagrams: Include [multi-color] single-line diagrams of electrical distribution system within scope of this project. In hardcopy versions, use folded ANSI B sheets (279 mm x 432 mm (11" x 17")). Single-line diagrams shall include:

    a. Transformer rating, voltage rating, impedance, and wiring connection.
    b. Feeder cable phase, neutral, and ground sizes, length of cable, conductor materials, and conduit size and type.
    c. Switchgear, switchboards, panelboards, MCC's, fuses, circuit breakers, ATS's, and switches continuous ratings
    d. Protective relays with appropriate device numbers and current transformers (CTs) and potential transformers (PTs) with associated ratios.
    e. Busses and fault levels.
    f. Detailed legend indicating device type identification and other significant details.
    g. [Identify all locations of Neutral-Ground bonds per Engineer of Record.]

5. All studies, reports, and associated diagrams shall be submitted to Project Director/COR prior to final review of electrical distribution equipment shop drawings, and prior to release of associated electrical equipment for manufacture.

    a. If formal completion of study may cause delay in equipment manufacture, approval from Project Director/COR may be obtained for preliminary submittal of sufficient study data to ensure that selection of device ratings and characteristics will be satisfactory. Formal final study will then be provided to verify preliminary findings.

6. Prior to submitting final versions of each report to Project Director/COR, transmit these versions to Engineer of Record for their approval. Based on recommended system improvements in project design, and on submittal comments themselves from Engineer of Record and from the Government reviewers, each report may require re-submittal; if so, final versions of those reports shall be corrected and resubmitted until it is approved by the Engineer of Record.

E. Fault-Current Study Report: Shall include equipment evaluation table or spreadsheet and information required in the Part 1 Article on FAULT CURRENT STUDY below.

F. Coordination Study Report: Shall include Device Setting tables or spreadsheet, Time-Current Curves, and information required in the Part 1 Article on COORDINATION STUDY below.

G. Arc Flash Hazard Study Report: Shall include table or spreadsheet that shows arc flash energy levels in cal/cm^2, comparing both worst case and ARMS enabled conditions for major and/or main bus locations. Provide arc flash labels reproductions in hard copy submittals. See the Part 1 Article on ARC FLASH STUDY below for more detailed requirements.

1.3 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: Organization experienced in application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

F. Comply with NFPA 70E “Standard for Electrical Safety in the Workplace.”

1.5 FAULT CURRENT STUDY

A. Source Impedance: As an infinite bus on primary side of utility transformer.

B. Analyze electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project, using approved computer software program to calculate values.

1. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculate interrupting ratings of overcurrent protective devices to verify compliance with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015, IEEE C37.13, and IEEE C37.50.
2. Low-Voltage Fuses: IEEE C37.46.

E. Data Presentation: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults. Show Fault current calculations including a definition of terms and guide for interpretation of computer printout.

F. Equipment Evaluation: Analyze adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties. Provide tabulations of circuit breakers, any fuses, and other protective device ratings versus calculated short circuit duties and commentary regarding it.

1.6 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings. Examine overcurrent protective device construction submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Construction Drawings.
2. Impedance of utility service entrance.
3. Electrical distribution system diagram showing the following:

    a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
    b. Circuit-breaker and fuse-current ratings and types.
    c. Relays and associated power and current transformer ratings and ratios.
    d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    e. Generator kilovolt amperes, size, voltage, and source impedance.
    f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
    g. Busway ampacity and impedance.
    h. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets shall supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Magnetic inrush current overload capabilities of transformers.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Ratings, types, and settings of utility company's overcurrent protective devices.
    e. Special overcurrent protective device settings or types stipulated by utility company.
    f. Time-current-characteristic curves of devices indicated to be coordinated.

g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

5. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

B. Perform coordination study and prepare a written report using results of fault-current study and approved computer software program.

C. Study shall reflect compliance with the OBO Electrical Code (NFPA 700 "National Electrical Code" as amended by OBO) for overcurrent protection of circuit elements and devices.

D. Study shall reflect compliance with IEEE 242 recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:

1. Study shall reflect that devices do not operate in response to the following:

a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
c. Inrush current when first energized.

2. Study shall reflect that devices protect transformer according to IEEE C57.12.00, for fault currents.

F. Study shall reflect that motors served by voltages more than 600 V are protected according to IEEE 620.

G. Conductor Protection: Study shall reflect that cables are protected against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. Coordination-Study Report: Prepare report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepare curves to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices including relay and circuit breaker trip settings, fuse selection, and commentary regarding it.

1.7 ARC FLASH STUDY

A. General: Perform study to:

1. Determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) on all major equipment in distribution system (i.e., transformers, switchgears, switchboards, motor control centers (MCC), panelboards, automatic transfer switches (ATS), uninterruptible power supplies (UPS), and variable frequency devices (VFD)).
2. Calculations shall comply with NFPA-70E, and IEEE-1584.

a. Bolted short circuit calculations used in above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399.

3. Determine arc flash hazards in conformance with NFPA-70E, by using a comprehensive software model of the complete electrical distribution system, which provides arc flash calculations for all equipment covered by this project.

B. Arc flash study shall determine results identified below for each system mode of operation. Provide results in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged, and spreadsheet comparison table shall be capable of providing its output directly to high quality label printers. Calculations shall, as a minimum, include comparison of both 100 percent and 85 percent arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. Spreadsheet results shall include:

1. Equipment name and voltage.
2. Upstream equipment device name and ANSI function (e.g., 51/50).
3. Equipment type (e.g., switchgear, MCC, Panel, VFD).
4. Equipment arc gap.
5. Bolted and estimated arcing fault current at fault point (equipment) in symmetrical amperes. Estimated arcing current shall be based on arcing current equations used.
6. Trip time, opening time, and total clearing time (total arc time) of protective device.
7. Worst-case arc flash boundary for each bus/equipment in model.
8. Worst-case arc flash hazard incident energy in cal/cm2 for each bus/equipment in model.
9. Worst-case personal protective equipment (PPE) for each bus/equipment in model.
10. Working distances for up to five different distances showing three worst-case scenarios above for each distance.
11. Indicate "Danger" designation for equipment locations where incident energy is greater than 40 cal/cm^2 and provide recommendations to reduce arc flash energy levels for these locations. Provide "Danger" labels as indicated in Attachment B below.
12. Flag results where 85 percent arcing current provided worst-case results.
13. Provide maintenance mode arc flash reduction switch to provide dual parameter sets that enable trip unit to automatically lower instantaneous setting and thereby lower available energy in fault condition (commonly referred to as "maintenance mode"), making breaker trip faster while engaged in any form of maintenance while being in proximity to energized equipment to minimize arc flash dangers. Arc flash reduction maintenance switch shall reduce to below hazard identified in NFPA 70E hazard class ratings of 3 or greater.

C. Modes of Operation: Describe in detail each mode of operation, indicating areas where incident energy calculations and PPE requirements are higher than calculated in normal operating mode.

D. Equipment with ARMS: For equipment with Arc Reduction Maintenance Switches (ARMS), arc flash study shall identify information required for both normal operating mode and maintenance (ARMS) mode.

1. ARMS mode shall reduce arc flash levels to accommodate safe worker operation and maintenance of 8 cal/cm^2. If 8 cal/cm^2 cannot be reached, steps to provide alternative means of compliance to achieve worker safety, when approved by the Project Director/COR based upon input from OBO/PDCS/DE/EE electrical engineer, shall be identified. Candidate measures to achieve alternative means of compliance, used individually or in combination, include the following:

   a. Additional isolation procedures beyond baseline procedures required for all major electrical and mechanical equipment.
   b. Physical separation during testing and operations.
   c. Remote operations and testing.
   d. Additional safety accessories; see Section 260508 "Common Work Results for Electrical, Communications, and Electronic Safety" for baseline accessories.
   e. Provide permanent ARMS Notice Labels as required in the Part 3 Article on ARC FLASH HAZARD WARNING LABEL below. Provide a table or spreadsheet in the Arc Flash Study that shows arc flash energy levels in cal/cm^2, comparing both worst case and ARMS enabled conditions at each switchgear or switchboard location where ARMS are located.

E. General Report Contents: Provide detailed arc flash analysis report including as minimum:

1. Introduction.
2. Methodology.
3. Information Sources.
4. Key Assumptions.
5. Arc flash energy and other consideration for various system modes of operation (e.g., maintenance mode using ARMS, bus-tie).
6. Arc energy at 100 percent and reduced currents.
7. IEEE 1584-2002 Considerations.
8. Overcurrent protective device changes, replacements or setting changes implemented in study to reduce arc flash hazard exposure.
9. Explanation of data in arc flash hazard report tables.
10. NFPA 70E Information.

    a. Shock hazards with covers removed.
    b. Shock Hazard Approach Boundaries: Limited Approach Boundary and Restricted Approach Boundary.
    c. Arc Flash Hazard Boundaries.

11. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:

    a. Working distances.
    b. Energy Levels.
    c. PPE Requirements.
    d. Recommendations to reduce arc flash hazard energy and exposure. Identify where baseline arc flash level cannot be achieved and identify any alternative means of compliance if available.

F. Study Support: Contractor shall provide support necessary to facilitate study.

1.8 OWNERSHIP OF PROPRIETARY MATERIAL

A. The Government shall retain all rights to software and passwords used for this project.

B. The Government will sign a copy of manufacturer's standard software and firmware licensing agreement as condition of this contract. Such license shall grant use of all programs and application software to Government as defined by manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude use of software by individuals under contract to Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to Government shall be restricted to use on Government's computers, and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation shall be compatible and operable with SKM software, and become property of Government. These include but are not limited to:

1. Single line diagram identifying buss and fault levels (pdf).
2. Server and Workstation software
3. Application Programming Tools
4. Application Files
5. Configuration Files
6. Graphic Files
7. Report Files
8. Graphic Symbol Libraries
9. All Documentation.

PART 2 - PRODUCTS

2.1 SOFTWARE FOR STUDY

A. Available Computer Software Vendors: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

1. CYME International, Inc.
2. EDSA Micro Corporation.
3. Electrical Systems Analysis, Inc.
4. SKM Systems Analysis, Inc.

B. Software shall facilitate conformance with IEEE 399, IEEE 1584, and NFPA 70E.

C. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

D. Software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Additional Reporting Capabilities:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

E. Arc Flash Study Software:

1. General: Software shall provide complete integration of one-line, database, short circuit, PDC and Arc flash functions. Software using separate short circuit, PDC, TCC or arc flash programs is not permitted. Spreadsheet calculations are not permitted. Include program arc flash hazard calculations with necessary features to eliminate errors in arc flash calculations. **[Detailed software model shall be established for site electrical distribution system which documents site compliance with the OSHA and NFPA 70E**

requirements. This model will serve as an integral part of site ongoing safety program by providing ability to prepare integral work permits and arc flash calculations in compliance with NFPA-70E Article 130.1(A)(2) for each electrical equipment on compound.]

2. Software shall perform arc flash calculations with enhanced IEEE-1584 equations, which eliminate voltage discontinuities and non-conservative/average results of standard equations. This will ensure that calculated incident energies are closer to actual test results ensuring conservative calculation minimizing personnel risk.
3. Software shall perform arc flash calculations on fastest clearing upstream protective device protecting equipment for single sources and slowest upstream protective device for multiple sources. Calculations shall automatically compare all series and parallel upstream protective devices in system to determine the fastest series device or conservative parallel clearing time. Algorithm shall incorporate traversing routine that can search back unlimited number of buses/nodes and consider all series and parallel branches in comparison to ensure accurate answers and to prevent hazards associated with incorrect results. Software shall not have trace back limits (5-10 buses) that can provide incorrect answers for low voltage faults that require high voltage protective device clearing to prevent potential errors.
4. Software shall display arc flash calculations including arc flash boundary, incident energy, PPE requirements, and working distance on one-line diagram and TCC simultaneously. Software shall show visually the arc flash values as settings are incrementally changed (dragging curves) so protection can be optimized, allowing protection engineer to visually balance competing objectives of personnel protection with that of system selectivity.
5. Software shall include four calculation options for arc flash calculations to ensure that software provides flexibility required to meet any system configuration or training requirement that may be considered. Each calculation option shall comply with graphic and spreadsheet display requirements of this section. These options are as follows:

    a. Option 1: Detailed option shall provide let-through energy for each protective device in system or on selected equipment. This is energy on load side of protective device. Equipment shall be highlighted when let-through energy exceeds user defined threshold-clothing limit.
    b. Option 2: Worst-case including main protective device. This option shall provide worst-case arc-hazard energy for equipment based on let-through energy of equipment's main protective device. If equipment is not equipped with main device, program shall traverse back entire system to determine fastest series upstream protective device. Equipment shall be highlighted when let-through energy exceeds user defined threshold-clothing limit.
    c. Option 3: Worst-case excluding main protective device. This option shall provide worst-case arc-hazard energy for equipment based on let-through energy of fastest upstream series protective device in system. Program shall traverse back entire system to determine fastest upstream protective device. The equipment shall be highlighted when let-through energy exceeds user defined threshold-clothing limit.
    d. Option 4: Worst-case excluding and including main protective device. This is a combination of Options 2 and 3.

6. Software shall produce arc flash calculations that provide integral "Work Tasks" for listed equipment types. Tasks shall be derived from 70E Table 130.7(C)(9)(a), and be specific

to equipment type. Work tasks shall be user definable in software to allow customization and integral with "Work Permit" feature of software. Listed equipment types shall include:

a. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 100-200 volt equipment.
b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 200-1000 volt equipment.
c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 1.0-5.0 kV equipment.
d. Switchgear, MCC, VFD, ATS, Interrupting Switch, NEMA E2 Contactor, Conductor, Open Air for 5.0-15.0 kV equipment.
e. Switchgear, Interrupting Switch, Conductor, Open Air for 15.0-38.0 kV equipment.
f. Interrupting Switch, Conductor, and Open Air for 38.0-1500 kV equipment.

7. Work Tasks shall have user-defined library that provides the following customizable features for each work task:

a. Work Tasks for each specific equipment type and voltage range.
b. Working distance units English or Metric.
c. Work distance for each task.
d. Voltage-rated gloves and tool requirements.
e. Job description and procedures.
f. Safe work practices description.
g. Hazard Risk Category (HRC) reduction. HRC reduction shall only be used based on documented risk assessment as integral part of safety program.

8. [Software shall permit preparation of work tasks that are accessible from one-line diagram for any equipment through mouse click on equipment in electrical system model one-line. Dialog box shall appear listing all 70E and user definable work tasks for specific equipment selected. Work task dialog shall include user definable working distance for each work task and allow user to select tasks specific to any equipment feeder or incoming main. Work tasks for each equipment type shall be voltage specific and user definable in library. These requirements integrate 70E work tasks to one-line diagram for specific equipment types, providing basis for customized safety program and work permit process compliant with 70E mandates. Detailed requirements for "work task" software is necessary to ensure that any variation of equipment type, equipment layout, or work procedure can be handled and documented in software.

a. Software interface shall allow user to select any breaker fuse or switch on one-line and get specific work task generated for that device showing load side arc flash hazard (let-through energy) for that device. The purpose of this requirement is to detail specific feeder hazards when work tasks dictate working downstream from feeder protective device.
b. Software shall produce integral work permits from arc flash calculations to comply with NFPA-70E, 2004 Article 130.1 (A). Work permits shall be integral with system one-line diagram and arc flash calculations and shall detect and account for work between feeder and main breaker.]

9. [Software shall allow work permits to be activated by mouse click for all equipment types listed in F5. Work permits shall have the following calculated values and provide the following information specific to "work task" and equipment selected:

a. Shock hazard.
b. Shock hazard boundaries.
c. Arc flash boundary – worst-case for each equipment.
d. Arc flash hazard incident energy in cal/cm2 for the equipment.
e. Hazard Risk Category (HRC) and any applicable risk reduction.
f. Required PPE category based on calculated energy level and optional risk reduction.
g. Required PPE description based on PPE category.
h. Determination of V-rated gloves and tools.
i. Auto fill job description and procedures for each work task.
j. Auto fill safe work practices description for each work task.
k. Job briefing and planning check list.
l. Approval sign off section.
m. Working distance measurements in English or Metric units.
n. Required work distance for each task.
o. Documentation for safety program in compliance with 70E 130.1(A).]

10. [Software shall create work permits in MS Word, and have the following user customizable features:

a. Work Tasks for each specific equipment type and voltage range.
b. Restricted shock boundary.
c. Arc flash boundary – worst-case for each equipment.
d. Arc flash hazard incident energy in cal/cm^2 for the equipment.
e. Hazard Risk Category (HRC) reduction for low risk tasks.
f. Required PPE category based on risk reduction.
g. Working distance in English or Metric units.
h. Working distance for each task.
i. Voltage-rated gloves and tool requirements.
j. Arc resistant clothing requirements.
k. Job description and procedures for each work task.
l. Safe work practices description for each work task.
m. Job briefing and planning check list.
n. Approval sign-off section.]

11. [Power system software shall allow created work permits to be linked via MS Windows "hyperlinks" to each equipment on one-line diagram. This will facilitate developing data repository of work permits performed on each equipment for 70E review, as well as providing one-stop location where documents pertaining to equipment can be accessed by maintenance and job planning.]

12. Power system software shall be fully compatible with facility arc flash hazard and electrical safety implementation software that provides the following capabilities:

a. Calculates shock hazards, shock hazard boundaries, arc flash boundaries, incident energies, PPE requirements, and similar analyses for power systems modeled in EasyPower or EasyPower EasySolv or approved equal.

b. [Built in Work Permit Feature for creation of custom Energized Work Permits complying with the NFPA-70E requirements. Work permit feature shall include NFPA risk assessment categories based on task performed for all types of electrical equipment and voltage ranges. Work permit feature shall include extensive library of user definable work tasks, safety procedures and safe work practices.]

c. [Energized work permits, safety procedures, equipment instruction manuals, and similar items produced by software shall be capable of being directly linked to equipment one-line through Hyperlinks feature, providing one-stop data repository easily accessible to all plant and safety personnel, saving plant personnel and contractors significant productive time in locating applicable instruction manual, equipment safety procedure, drawing, pictures and maps for equipment. This feature will assist compliance with OSHA and NFPA 70E record keeping requirements.]

d. Additional equipment information and records such as Maintenance Records, Maintenance Manuals, Operations Manuals, Lock out / Tag out procedures shall also be capable of being Hyperlinked to equipment on graphical one-line.

e. Program shall support creation of arc flash labels.

f. Program shall also have customizable output, allowing one-line printing, text report creation, export to AutoCAD, and similar operations.

g. Program shall be a MS Windows-based operating system and shall use MS Windows conventions.

h. Program shall be capable of being installed on standalone personal computers or on networked systems and shall be compatible with all systems operating on MS Windows 2000 or later operating systems.

i. Program shall be easily operable by site Facility staff without any specialized training.

PART 3 - EXECUTION

3.1 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment. If study recommends different type of devices or equipment, provide it at no additional cost to Government.

B. Testing: Engage qualified testing agency to perform the following device setting and to prepare test reports.

3.2 ARC FLASH HAZARD WARNING LABELS

A. Required Label Information: Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling units, and that are likely to require examination, adjustment, servicing, or maintenance while energized, shall be field-marked with label containing all of the following information:

1. Nominal System Voltage
2. Arc Flash Boundary
3. Available incident energy and the corresponding working distance
4. Shock hazard boundaries, Limited and Restricted Approach
5. Arc Flash PPE for calculated incident energy
6. Insulated glove class
7. Date of Study

B. Placement: Place shock and arc flash hazard warning labels, prepared using software, onto electrical components and devices as determined in arc flash study.

C. Label Types: Refer to Attachments A and B at the end of this Section for illustration of label types that shall be used for applicable warning conditions.

D. For ARMS equipment, provide a Notice Label alerting the user that the equipment is provided with ARMS capability. Mount these on the face of the equipment in prominent locations near the most upstream ARMS. The Notice Label shall say the following (unless alternate wording is approved by OBO) :

> "This equipment is provided with Arc Reduction Maintenance Switch (ARMS) capability. The switches, when enabled in 'maintenance mode', will result in less potential fault current and lower incident energy in downstream equipment. Qualified technicians must refer to the arc flash study, located with this equipment, for arc flash guidance when engaging the ARMS".

Provide a bound copy of the complete arc flash report in the O&M manual storage location for any gear where any ARMS switches are present. The bound report shall include the table or spreadsheet that compares worst case and ARMS enabled arc flash energy levels as required in the Part 1 Article on ARC FLASH STUDY above.

3.3 ARC FLASH TRAINING

A. Provide training by qualified specialist who also understands specific Arc Flash Hazard Analysis for this site. Training shall be for site qualified electrical Post Facilities personnel.

B. Training session shall address:

1. Potential arc flash hazards associated with working on energized equipment.
2. Proper use of system analysis data.
3. Interpretation of hazard labels.
4. Selection, and utilization of personal protective equipment.

5. Baseline isolation procedures for electrical and mechanical equipment.
6. Alternative means of compliance for worker safety where implemented for specific equipment; refer to the paragraph on "Equipment with ARMS" in the Part 1 Article on ARC FLASH STUDY.
7. How to safely operate the ARMS and how to interpret ARMS information and the arc flash report.
8. Preparation of Energized Work Permits.

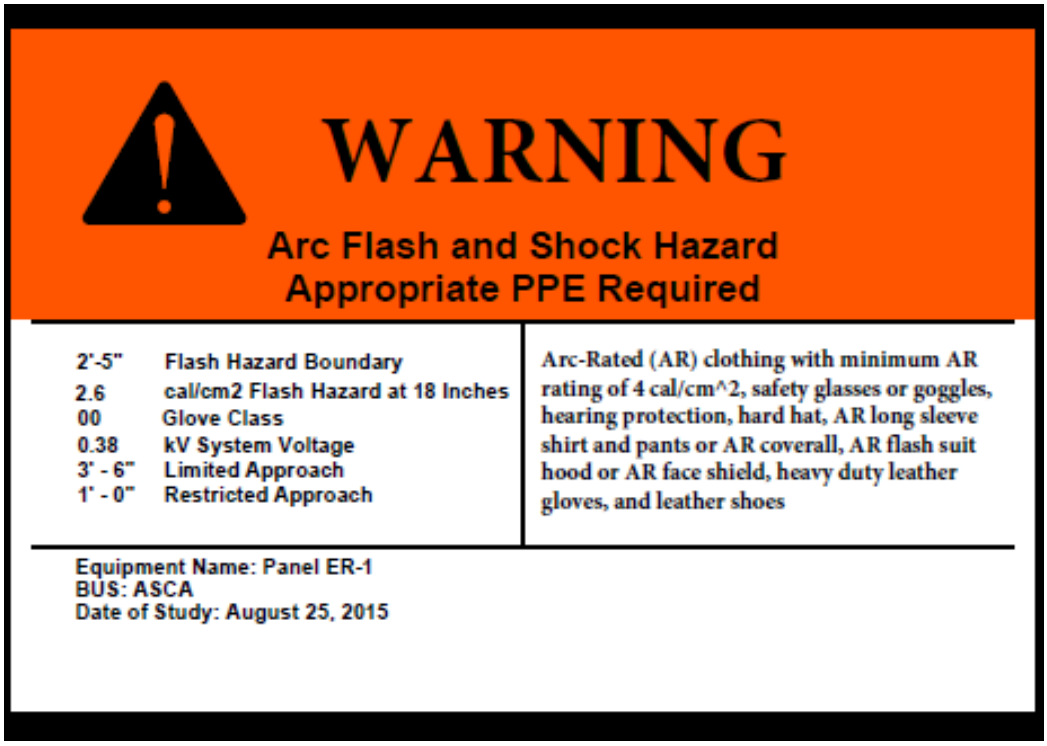
C. Session shall be four hours minimum duration, with trainees using (at applicable portions of session) proper Personal Protective Equipment (PPE) provided by Contractor.

D. Training shall be certified for continuing education units (CEUs) by International Association for Continuing Education Training (IACET) or equivalent.

E. Coordinate with training for lock-out/tag-out devices and safety accessories in Section 260508 "Common Work Results for Electrical, Communications, and Electronic Safety."

ATTACHMENT A

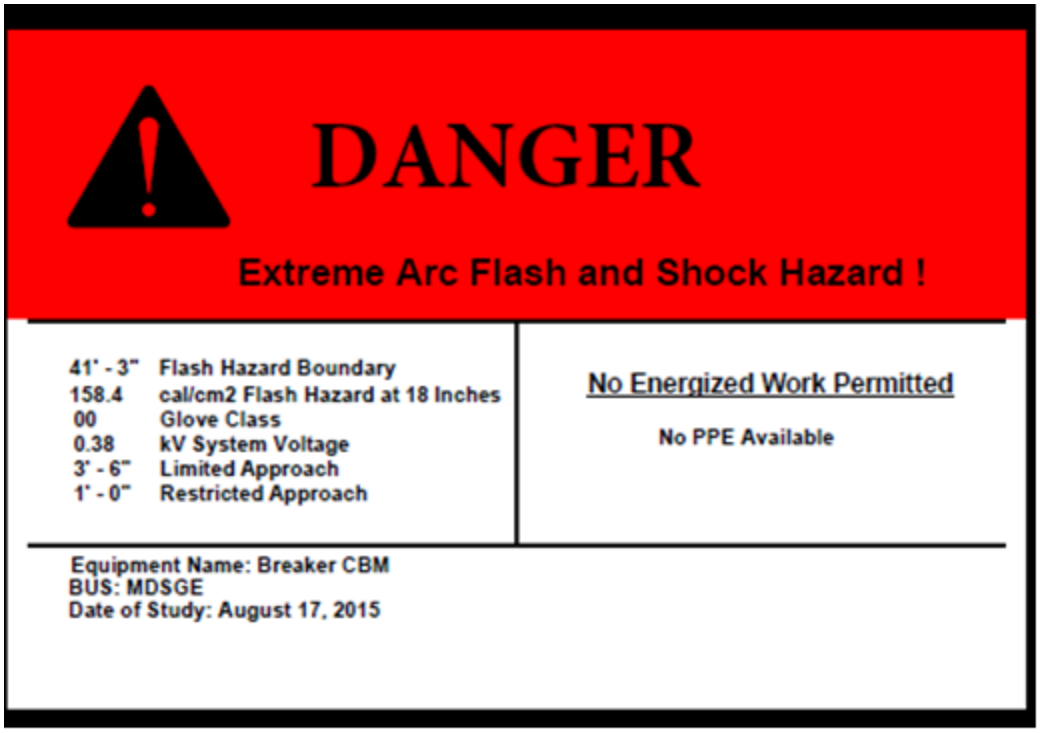
EXAMPLE OF BASIC ARC FLASH WARNING LABEL



UNCLASSIFIED

ATTACHMENT B

EXAMPLE OF SHOCK HAZARD WARNING LABEL



END OF SECTION 260573

UNCLASSIFIED

SECTION 260815 - FIELD TESTING AND INSPECTION OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general requirements for field testing and inspection of electrical systems. More detailed requirements are specified in each Section listed in the "Related Sections" paragraph. General requirements include the following:

1. Qualifications of testing agencies and their personnel.
2. Suitability of test equipment.
3. Calibration of test instruments.
4. Coordination requirements for testing and inspecting.
5. Reporting requirements for testing and inspecting.

B. Related Sections include the following:

1. Section 260508 "Common Work Results for Electrical, Communications, and Electronic Security," including for electrical safety accessories.
2. Division 26 Section on medium-voltage cables.
3. Section 260518 "Low-Voltage Electrical Power Conductors and Cables."
4. Section 260525 "Grounding and Bonding for Electrical Systems."
5. Section 2605073 "Overcurrent Protective Device Coordination Study."
6. Section 260915 "Electrical Power Monitoring."
7. Section 260924 "Lighting Control Devices."
8. Section 260934 "Centralized Dimming Controls."
9. **[Division 26 Section on secondary unit substations.]**
10. Section 261214 "Medium-Voltage Transformers."
11. **[Division 26 Section on medium-voltage switchgear.]**
12. Section 262214 "Low-Voltage Transformers."
13. Section 262300 "Low-Voltage Switchgear."
14. Section 262313 "Paralleling Switchgear."
15. Section 262315 "Double-Ended Switchgear."
16. Section 262325 "Power Sequence of Operation."
17. Section 262412 "Switchboards."
18. Section 262417 "Panelboards."
19. Division 26 Section on motor-control centers.
20. Section 262500 "Enclosed Bus Assemblies."
21. Division 26 Section on fused power circuit devices.
22. Division 26 Section on enclosed switches and circuit breakers.
23. Division 26 Section on enclosed controllers.
24. Division 26 Section on variable frequency motor controllers.
25. Section 263214 "Engine Generators."
26. Section 263354 "Uninterruptible Power Supply for Telecommunications."
27. Section263237 "Resistive Load banks."

28. Section 263535 “Power Factor Correction Equipment.”
29. [Section 263552 “Low-Voltage Regulators.”]
30. [Section 263554 “Medium Voltage Regulators.”]
31. Section 263600 on “Transfer Switches.”
32. Section 264115 “Lightning Protection.”
33. Section 264315 “Surge Protective Devices.”

1.2 QUALITY ASSURANCE

A. Independent Testing Agency: Provide the services of an Independent Testing Agency for field testing and inspection of each system listed in the “Related Section” paragraph of this Section.

1. Qualifications: Independent of manufacturers, suppliers, and installers of components to be tested or inspected.

a. Testing Agency's Field Supervisor for Power Component Testing: Person currently certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in Division 26 power component Sections.

B. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.

C. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL TESTING AND INSPECTION PROCEDURES

A. Testing Preparation: Prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for Independent Testing Agency testing. Include the following minimum preparations as appropriate:

1. Perform insulation-resistance tests.
2. Perform continuity tests.
3. Perform rotation test (for motors to be tested).
4. For all circuit breakers rated at 200 amperes and above, perform injection testing per NETA standards.
5. Provide a stable source of electrical power for test instrumentation at each test location.

B. Field Test and Inspection Reporting: In addition to requirements specified in Related Sections, ensure that each test and inspection report includes the following:

1. Manufacturer's written testing and inspecting instructions.
2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
3. Tabulation of expected measurement results made before measurements.
4. Tabulation of "as-found" and "as-left" measurement and observation results.

3.2 SAFETY DURING TESTING

A. In advance of testing and commissioning, review project-specific safety recommendations from reports prepared in accordance with Section 260573 “Overcurrent Protective Device Coordination Study.” Use safety accessories provided in Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”

END OF SECTION 260815

SECTION 260915 - ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes monitoring of electrical power and lighting circuits through electronic communication links between devices in distribution system components and power monitoring units.

1. Power monitoring units include the following:

a. Local display panels.
b. Central-processing workstation personal computers.
c. Remote workstation personal computers.

B. Related Sections include the following:

1. Section 230905 “Instrumentation and Controls for HVAC” for building automation system (BAS).
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
3. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
4. Division 26 Section on raceways and boxes.
5. Division 26 Section on identification for electrical systems.
6. **[Section 262313, “Paralleling Switchgear” for load shedding.]**
7. Section 262315 “Double-Ended Switchgear.”
8. Section 262325 “Power Sequence of Operation.”

1.2 TECHNOLOGY RESTRICTIONS

A. In accordance with Chapter 1 of the OBO Electrical Code, power monitors and controls may not contain ultrasonic technology, or wireless technology, even if not implemented. This includes prohibition of Wi-Fi, Bluetooth, Near Field Communication, ZigBee, Low Power Wide Area Networks, and similar technology.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. LAN: Local area network, sometimes plural as "LANs."

C. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

D. PC: Personal computer, sometimes plural as "PCs."

E. PV: Photovoltaic.

1.4 SYSTEM DESCRIPTION

A. Distribution system components which require monitoring include the following:

1. Medium-voltage switchgear: Meters, breaker trip units.
2. Transformers: Status/alarm points.
3. Low-voltage switchgear: Meters, breaker trip units.
4. Switchboards: Meters, breaker position.
5. Panelboards: Meters if sub-metering.
6. Motor controllers: Power monitoring is required in addition to Building Automation System (BAS) monitoring.
7. Motor-control centers: Power monitoring is required in addition to BAS monitoring.
8. Generators: Electrical and mechanical real-time and status/alarm points.
9. Transfer switches: Electrical real-time points, position, sources available.
10. Paralleling switchgear: Meters, breaker trip units.
11. Joint-Unclassified Communications (JUCR) Uninterruptible Power Supply (UPS): Status/alarm points.
12. Voltage regulators: Electrical and mechanical real-time and status/alarm points.
13. Load bank: Meter.
14. Fuel system: Fuel system real-time status/alarm points.
15. Day tanks: Status/alarm points.
16. Electrical distribution system ground current: Monitor for potentially Objectionable Current as described in Article 250 of the OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO). As a minimum, grounding conductors identified below shall be monitored for objectionable current. Metering shall measure ground currents with at least 5 percent accuracy down to 50 milliamp range as required by leakage currents anticipated; damage shall not occur to any metering components during any ground fault event.

    a. Main Bonding Jumpers within Main Service Equipment or Grounding Electrode Conductors connecting Main Bonding Jumper to **[compound][counterpoise]** ground rod system.
    b. Equipment Grounding Conductors (EGC) including all EGCs installed between Service Transformer secondary and Main Service Equipment.

17. [Photovoltaic Data acquisition system.]

18. [Wind Turbine Data acquisition system.]

1.5 SUBMITTALS

A. Product Data: List of components for power monitoring, including dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes. Attach copies of Submittals for effected products (such as switchboards and switchgear) that describe power monitoring features to coordinate Product Data related to power monitoring.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.

1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Wiring Diagrams: Detail specific wiring to suit Project. Coordinate nomenclature and presentation with a block diagram and differentiate between manufacturer-installed and field-installed wiring.

C. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

D. Software Upgrade Kit: For Government to use in modifying software to suit future power system revisions, or in power monitoring revisions.

E. Qualification Data: For firms and persons specified in Article on QUALTIY ASSURANCE.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Maintenance Data: For power monitoring equipment components.

1.6 QUALITY ASSURANCE

A. Startup Personnel Qualifications: Engage specially trained personnel who are directly employed by a manufacturer of distribution system protective devices.

B. Installer Qualifications: Experienced installer who is an authorized representative of power monitoring equipment manufacturer for both installation and maintenance of units required for this Project.

C. Manufacturer Qualifications: Firm experienced in manufacturing power monitoring equipment similar to that indicated for this Project and with record of successful in-service performance.

D. Source Limitations: Obtain power monitoring, firmware, monitoring panels, and network components from same manufacturer as for distribution equipment circuit breakers and other protective devices.

E. Comply with the requirements of the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for indicated use and installation conditions.

F. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

G. Comply with UL 916.

1.7 COORDINATION

A. Coordinate features of distribution equipment and power monitoring components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.
2. Coordinate Work of this Section with BAS so that BAS PC workstations indicate and record designated alarms registered in power monitoring displays.

a. Coordinate power monitoring components so metered electrical load and demand values and associated summary and trend reports available at central-processing workstations specified in this Section are made accessible at BAS workstations.
b. Log and store data from power monitoring system to facilitate production of monthly reports associated with each building.
c. Provide capacity to maintain logged data for a minimum of ten years. Provide auto archive capability and locally accessible storage.
d. [Where photovoltaic (PV) systems are used, all data from PV data acquisition system shall be monitored and provided to compound power monitoring system. See Section 263105 "Solar Photovoltaic Systems."]
e. [Where wind turbine systems are used, all data from wind turbine data acquisition system shall be monitored and provided to compound power monitoring system. See Division 26 Section on wind turbine systems.]

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored by power monitoring equipment.

C. Coordinate a communication link with BAS to meet input requirements of BAS integrator and gateway equipment provided as part of BAS installation.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Communication Power Supplies: One of each type installed.
2. Network Interface Cards: One of each type installed.
3. Fiber Converters: One of each type installed.
4. Ethernet Switches: One of each type installed.
5. Meters: One of each type installed.

PART 2 - PRODUCTS

2.1 WORKSTATIONS AND SOFTWARE

A. Central-Processing Workstation: Desktop PC shall be models that were released to the market no more than two years prior to when workstation is installed, and shall be commercial-off-the-shelf models. With minimum installation, workstations shall be capable of communicating with a minimum of 200 devices, and including the following minimum peripherals, accessories, and features:

1. RAM: **[16GB][X GB]**.
2. Hard-Disk Drive: **[1 TB][X TB]**.
3. CPU: minimum 3 Ghz.
4. CD-ROM Drive: 24X read/write.
5. Monitor: 532 mm Multisync with 0.25-mm mask pitch and 1024 by 768 resolutions at 100 Hz.
6. Operating System: Microsoft Windows **[XP][7][8][X]** OS.
7. Keyboard and mouse: Compatible with Microsoft Windows **[XP][7][8][X]** OS.
8. One serial and one parallel port in addition to those required for power monitoring.
9. Network Interface Card: Computer operated, with two-way communication transmitter-receiver chip.
10. Modem: External, 56 K, minimum.
11. Automatic Reboot Capability: When power is restored after an outage.
12. Printer: Laser jet. Six pages per minute minimum nominal printing rate in draft mode.
13. Backup Battery-Inverter Power Supply: Automatic, rated 650-VA output for 10 minutes. Arranged to supply computer, accessories, and peripherals, not including a printer. Include transient voltage surge suppressor and electromagnetic-interference filters.

B. Remote Workstations: Desktop PCs that include the following features:

1. RAM: **[2GB] [X GB]**.
2. Hard-Disk Drive: **[500 GB] [X GB]**.
3. CPU: Minimum 3 GHz.
4. CD-ROM Drive: 24X read/write.
5. Monitor: 532 mm Multisync with 0.25 mm dot pitch and 1024 by 768 resolutions at 100 Hz.

6. Operating System: Microsoft Windows **[XP][7][8][X]** OS.
7. Keyboard and mouse: Compatible with Microsoft Windows **[XP][7][8][X]** OS.
8. One serial and one parallel port.
9. Network Interface Card: Computer operated, with two-way communication transmitter-receiver chip.
10. Modem: External, 56 K, minimum.

C. Metering and Monitoring Software: Features and functions include the following:

1. Password Protection: Three configurable security levels, minimum.
2. Operates in multitasking, multiuser environment. Microsoft Windows **[XP][7][8][X]** compliant.
3. On-Line Help: Context sensitive.
4. Coordinates the communications of the network.
5. Provides interactive color-graphics platform with mouse-accessed menu and mouse-driven generation of distribution system graphics, including the following graphic image types:

    a. Site plan.
    b. Floor plans.
    c. Equipment elevations.
    d. Single-line diagram.

6. Provides mouse-driven interface with devices depicted in single-line diagram and equipment elevation screens.
7. Logs user-defined power monitoring and power distribution system events including log on/off; attempted log on/off; alarms; equipment operations; and out-of-limit, pickup, trip, and no-response events; with date and time stamps accurate to 0.1 second.
8. Exports and imports data to and from commonly used Microsoft Windows spreadsheet, database, tenant billing, whole building usage, and other applications; uses dynamic data exchange technology.
9. Reports Trends: Instantaneously, in a real-time or historical tabular format, bar chart, or user-defined time, trend plots of monitored parameters; unlimited as to interval, duration, or quantity of trends.
10. Manages Alarm Function: Annunciates and logs alarm messages from discrete input and monitoring outputs, according to programmable security access protocol using the communication network.

    a. Functions Requiring User Acknowledgment: Run in background during computer use for other applications and override other presentations when they occur.

11. Views and analyzes captured waveforms. Displays harmonic content through the twenty-first harmonic, minimum, and reports total harmonic distortion.
12. Defines and initiates load-shedding schemes responding to generator PLC system, or set points of metered demands, or combination of both. See Section 262313 “Paralleling Switchgear.”
13. Communicates with BAS main workstation PC.

D. Tenant or Activity Billing Software: For non-CAA areas, automatically computes and prepares activity demand and energy-use statements based on electricity metering of energy use and peak demand integrated over same interval used by electric utility.

1. Automatically imports historical metering data from memory, generated by metering and monitoring software.
2. Maintains a separate directory for each tenant's historical billing information.

a. List of Tenants is determined by project-specific Space Requirements Program (SRP).

3. Prepares summary reports.

E. Whole Building Usage: Automatically compute and prepare activity demand and energy-use statements for all buildings over 100 sm, based on electricity metering of energy use, reactive energy, and peak demand for 15-minute intervals.

1. Automatically imports historical metering data from memory, generated by metering and monitoring software.
2. Maintains separate directory for each tenant's historical billing information.
3. Prepares summary reports.
4. Stores up to 5 years of demand and usage data (kW and kWh) for each feeder serving buildings over 100 square meters.

F. Energy Usage: Automatically prepares activity report to provide whole facility energy report based on hourly inputs. This shall be identified as the 8760 report. This report shall follow National Renewable Energy Laboratory (NREL) guidance.

1. Provide annual 8760 reports from 00:00 Jan 1 to 24:00 Dec 31.
2. Provide current prior year report (current hour back 8760).

G. Communication Software: As recommended by manufacturer for high-speed communication via modem.

H. Meter Monitoring Requirements: All meters shall monitor and record the following data:

1. Monitoring of demand power (kW).
2. Energy usage (kWh).
3. Reactive Power (kVAR).
4. Harmonics.

2.2 LOCAL DISPLAY PANEL

A. Description: Microprocessor-based, self-contained device mounted in the door of switchboard or switchgear and arranged to display values of parameters metered at each of the monitored circuit breakers in the host equipment. Features include the following:

1. Communicates over power monitoring network.
2. Circuit breakers are selected for status and parameter display by programmable designations.
3. Circuit-breaker status and trip rating are displayed in addition to parameter values.
4. Nonvolatile memory retains programmed input data indefinitely during power outages.
5. Display Screen: Light-emitting diode or illuminated liquid-crystal display, or approved equivalent.

2.3 COMMUNICATION COMPONENTS AND NETWORKS

A. Surge Protective Devices (SPD) and Electromagnetic-Interference Immunity: Include in solid-state equipment. Comply with IEEE C37.90. SPD are also known as Transient Voltage Surge Suppression (TVSS).

B. Network Configuration: High speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, IEEE 802.3, 100 Base-T Ethernet, Modbus TCP/IP or other approved industry standard.

C. Network Interface Modules: Provide polling time supporting 30-second maximum interval between alarm initiation from monitored devices and registration and printout of alarm messages.

2.4 COMMUNICATION FEATURES OF POWER DISTRIBUTION SYSTEM DEVICES

A. Communication Function: Microprocessor based and integral to devices indicated as having power monitoring functions.

1. Communication Address: Unique to each individual device, and changeable at device.
2. Communication Protocol: Match that of network to which connected.
3. Two-Way Communication: Send and receive values and data communication indicated. Initiate alarm on malfunction of monitored device of monitoring equipment or network.
4. At minimum, devices shall be BacNet and MODBus compatible.

B. Circuit Breakers: Provide separate circuit breakers at power panels for each equipment rack, cabinet, or piece of electronic equipment. Connect individual pieces of equipment to panelboards with wiring for dedicated circuits run in cable racks or conduits, or combination of both.

1. Circuit Breakers, 600 V and Less: Include communication capability as feature of trip unit. Trip unit shall meter amps, volts, power per phase, three phase power, energy, power factor, frequency, alarm status, and trip events.
2. Medium-Voltage Circuit Breakers: Include communication capability as feature of overcurrent relay trip unit. Trip unit shall meter amps, volts, power per phase, three phase power, energy, power factor, frequency, alarm status, and trip events.

C. Motor Controllers, 600 V and Less: Include communication capability as feature of motor protection relay, or in network interface card designed to mount on controller. Provide electrical power monitoring in addition to BAS monitoring and control.

D. Multifunction Digital Meter and Power Quality Monitor: Microprocessor-based device, flush or semi-flush mounted in the door of switchboard or switchgear. Unit shall display and communicate indicated monitoring parameters and data for circuit and inputs to which connected. Unit shall have the ability to communicate and be connected to power monitoring system as specified in "Communication Function" Paragraph above plus the following:

1. Waveform data from high-speed sampling of voltage and current values metered.
2. Status of up to three external contact-monitored alarm conditions monitored by internal meter relay functions.
3. Monitoring of minimum of three programmable threshold values of metered parameters.
4. Monitoring of demand power (kW), energy usage (kWh), Reactive Power (kVAR), and Harmonics.

E. Addressable Monitoring Relay: Continuously polled for data, via the communication network, as to state (open or closed) of dry contacts of contact-making sensing device.

1. Ability to Communicate: As specified in "Communication Function" Paragraph above.
2. Power Supply Rating: 220 or 240 V ac or 48- to 240 V dc.
3. Enclosure: NEMA 250, Type 12, unless otherwise indicated.

2.5 ADDITIONAL POWER MONITORING COMPONENTS

A. Current Transformers: For multifunction digital meter and power quality monitors and other current-monitoring equipment furnished under this Section, without integral current transformers, provide factory-mounted current-transformer units.

1. Primary Rating: Equal to or more than that of associated circuit-breaker trip rating. Equip with shorting switches.

B. Potential Transformers: If those required for indicated monitoring functions are not integral to basic switchgear, circuit breakers, or circuit-breaker trip units, provide factory-mounted units.

1. Rating: Same as distribution system phase-to-neutral voltage.
2. Protection: Current-limiting fuses.

2.6 LOW-VOLTAGE WIRING

A. Data Line Cable: Shielded, twisted-pair cable.

B. Low-Voltage Cable: Multiple conductor, color-coded, 0.5 mm^2 copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

2.7 ACCESSORIES

A. Interfaces with Distribution Equipment Specified in Other Sections: Accessories, adapters, electronic interface units, and connections required for functional performance indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment level and plumb. Anchor to building structural elements and support according to requirements in Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”

B. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounting items.

3.2 WIRING INSTALLATION

A. Install wiring between power monitoring devices as specified in Section 260518 “Low-Voltage Electrical Power Conductors and Cables" for low-voltage analog connections, and for network and data line circuits.

B. Wiring Method: Install wiring in raceway as specified in Division 26 Section on raceways and boxes for electrical systems.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B “Standard for Wire Connectors.”

3.3 IDENTIFICATION

A. Identify components and power wiring according to Division 26 Section on identification for electrical systems.

B. Label each power monitoring module with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Engage a factory-authorized service representative to inspect, test, adjust, and program power monitoring equipment.

B. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

C. Inspect power monitoring components for defects and physical damage, labeling of testing laboratory, and nameplate compliance with the Contract Documents.

D. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.

2. Operational Tests: Set and operate controls at PC workstations and at monitored devices to demonstrate their functions and capabilities. Use methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored.
b. Metering Test: Load feeders, measure loads on feeder conductor with RMS reading clamp-on ammeter, and simultaneously read indicated current on same phase at central-processing workstation. Record and compare values measured at two locations. Resolve discrepancies greater than 10 percent and record resolution method and results.
c. Integration with BAS: Verify validity of displays at BAS PC workstations that are related to electrical power monitoring functions.
d. Record metered values, operations, cues, time intervals, and functional observations.

F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

G. Test Labeling: After satisfactory completion of tests and inspections, apply label to tested components indicating test results, date, and responsible agency and representative.

H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage factory-authorized service representative to provide on-site training of Government's locally employed staff (LES) maintenance personnel and Government's maintenance management to adjust, operate, and maintain systems.

1. Training Content: Train in interpreting and using monitoring displays and in configuring and using software and reports. Train in troubleshooting, servicing, adjusting, and maintaining equipment.
2. Training Duration:

   a. LES Maintenance Personnel: Provide 40 consecutive hours (one week) of training.
   b. Government Maintenance Management: Identify 16 hours of the training provided for LES maintenance personnel which would provide management with the best overview. Through Project Director/COR, confirm this content and schedule breakout (e.g., two full days or four ½ days) for participation of Government maintenance management in training sessions.

3. Training Aids: Use approved final versions of software and maintenance manuals as training aids.
4. Schedule training through Project Director/COR, with at least 14 days advance notice.

3.7 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Project Director/COR, to adjust and calibrate components and to assist Government personnel in making program changes and in adjusting sensors to suit actual conditions.

3.8 TELEPHONE TECHNICAL SUPPORT

A. Hardware and Software: Within two years of date of Substantial Completion, provide unlimited response to user questions regarding software use and hardware and communication link troubleshooting, reconfiguring, and adjusting.

1. Telephone Calls: Toll free.
2. Availability: Eight hours per day during Post working hours on weekdays.
3. Responder Qualifications: Engineer or technician thoroughly familiar with power monitoring equipment.

END OF SECTION 260915

SECTION 260924 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Outdoor photoelectric switches.
2. Indoor photoelectric switches and photosensors.
3. Indoor in-wall occupancy sensors switches.
4. Outdoor motion sensors.
5. Multipole contactors.

B. Related Sections include the following:

1. Section 122413 “Roller Window Shades” for coordinated interface of window shades on exterior wall of Consular Waiting Area.
2. Section 260934 “Centralized Dimming Controls” for architectural dimming system equipment.
3. Section 262725 “Wiring Devices” for wall-box dimmers and manual light switches.
4. Section 265105 “Interior Lighting” for LED fixtures.

1.2 DEFINITIONS

A. DALI: Digital Addressable Lighting Interface

B. LED: Light-emitting diode.

C. PIR: Passive infrared.

1.3 PERFORMANCE REQUIREMENTS

A. Provide sufficient quantity, layout, and aiming of devices to facilitate conformance with lighting requirements in Chapter 12 of the OBO Building Code, achieving at least at least 90 percent coverage in each area. Do not exceed coverage limits specified in manufacturer's written instructions.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Lighting plan showing location, orientation, and coverage area of each sensor.
2. Interconnection diagrams showing field-installed wiring.
3. In relation to the Consular Waiting Area show interface of lighting controls, located in the staff side of the Consular Section, with window shades at exterior walls of the Consular Waiting Area. Refer to Section 122413 on "Roller Window Shades."

C. Qualifications:

1. Testing agency.
2. Training instructor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product include detailed information on device programming and setup in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code, or BS EN 60079:2004 "Electrical Apparatus for Explosive Gas Atmospheres," by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section, with minimum three years documented experience.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies. Voltages listed shall be adjusted to match the host country voltage.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sensors: 10 per type.
2. Relays and Control Modules: Two per type.
3. Transfer Units (Normal/Emergency): Two per type.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: Integral part of devices for 220- or 240-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, and related accessories necessary for complete operating system.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Conform to system design requirements for exterior site lighting in OBO Zoning Code Appendix B.

B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, microprocessor input, and complying with UL 773A.

1. Light-Level Monitoring Range: 16 to 108 lx, with an adjustment for turn-on and turn-off levels within that range, and directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to North sky exposure in northern hemisphere or to South sky exposure in the southern hemisphere.

2.3 INDOOR PHOTOELECTRIC SWITCHES AND PHOTOSENSORS

A. Ceiling-Mounting Photoelectric Switch and Photosensors: Solid-state, light-level sensor unit, mounted in ceiling box or on luminaire if stand alone, to detect changes in lighting levels that are perceived by eye, and to provide dimming range as required by sequence of operation. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate associated relay or input to centralized control system, complying with UL 773A. Power sensor from relay unit, power pack, or centralized lighting control system.
2. Ceiling Mount with range and viewing angle to meet requirements of sequence of operation and as indicated in Construction Documents.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 220 and 240 V ac, for 13-A tungsten at 220 or 240 V ac, and for 1 hp at 220- or 240-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70 “National Electrical Code”

or BS 7671:2001 "Requirements for Electrical Installations-IEE Wiring Regulations-16th Edition."

4. Addressable Unit: DALI integrated with faceplate/finish trim and factory wiring connections.
5. Light-Level Monitoring Range: 108 to 2150 lx 1080 to 10 800 lx, with adjustment for turn-on and turn-off levels within that range.
6. Time Delay: Adjustable from five to 300 seconds to prevent cycling, with deadband adjustment.
7. Indicator: Two LEDs to indicate beginning of on and off cycles.
8. Response: Output signal shall be linear to light level. Cadmium sulfide photo-resistors are not acceptable.

B. Window/Skylight Photoelectric Sensors and Photosensors: Solid-state, light-level sensor; house in threaded, plastic fitting for mounting; under skylight, facing up at skylight, in ceiling adjacent to window, facing down; with separate relay unit mounted on luminaire, or integrated to centralized lighting control system, to detect changes in lighting levels that are perceived by eye, and to provide dimming range as required by sequence of operation. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Capacity: As required to meet requirements of construction documents.
2. Sensor Output: Contacts rated to operate associated relay or input to centralized control system, complying with UL 773A. Power sensor from relay unit, or centralized lighting control system.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 220 or 240 ac, for 13-A tungsten at 220 or 240 V ac, and for 1 hp at 220 or 240 V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70 "National Electrical Code" or BS 7671:2001 "Requirements for Electrical Installations-IEE Wiring Regulations-16th Edition."
4. Addressable Unit: DALI integrated, with faceplate/finish trim and factory wiring connections.
5. Light-Level Monitoring Range: 10 800 to 108 000 lx, with adjustment for turn-on and turn-off levels within that range.
6. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
7. Indicator: Two LEDs to indicate the beginning of on and off cycles.
8. Response: Output signal shall be linear to light level. Cadmium sulfide photo-resistors are not acceptable.

C. Lighting Control and Window Shade Control Interface for Consular Waiting Area:

1. Lighting and window shading system shall be controllable from common front-end system.

   a. Full functionality and integration of both systems shall be achievable without additional interfaces.
   b. Lighting and shade controllers shall communicate on same low voltage communication link for ease of installation and maintenance.
   c. At a minimum, lighting and shading control system front-end shall be able to provide cross system reporting of device status, activity history, and energy savings.

d. Window Shade Override Control: See Section 122413 “Roller Window Shades” for separate but adjacent control to facilitate override of window shade operation. The common front-end system shall permit the use of this override feature.

2.4 INDOOR IN-WALL OCCUPANCY SENSOR SWITCHES

A. General Description: Occupancy sensors designed for installation in standard wall box, at standard wall switch mounting height with field of view of 180 degrees, with integrated manual control capability, and no leakage current to load in off mode.

1. Operation - General: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion (walking) and minor motion (small desktop level movements), according to published coverage areas, for automatic control of load indicated; with time delay for turning lights off, adjustable over minimum range of 1 to 15 minutes.

   a. Auto/Auto: Turn lights on when covered area is occupied, and off when unoccupied.
   b. Manual/Auto: Manually turn lights on in covered area, and automatically turn lights off in covered area when unoccupied.
   c. Auto to 50 Percent Auto: Turn lights on when covered area is occupied to 50 percent with occupant having ability to adjust lights to 100 percent manually. Automatically turn lights off when unoccupied.

2. Sensor Output: Contacts rated to operate connected relay, complying with UL 773A. Power sensor from relay unit or power pack.
3. Mounting:

   a. Sensor: Suitable for mounting in any position on standard outlet box.
   b. Relay: Externally mounted though 13-mm knockout in standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

4. Indicator: Provide fade-to-off operation to warn occupant of impending load turn-off. LED indicator shall display when motion is being detected during testing and normal operation of sensor.
5. Bypass Switch: Override on function in case of sensor failure.
6. Selectable Option Light-Level Sensor: Enable low light feature (automatic-on when ambient light is below threshold). Ambient light threshold shall be adaptive utilizing occupant feedback.
7. Suitable to dim LED loads.

B. Dual-Technology Type: Detect occupancy by using combination of passive infrared (PIR) and ultrasonic detection methods in area of coverage; microphonic technology is prohibited.

1. Sensitivity Adjustment: Adjustable for high, medium, low, and off presets.

2. Selectable Option Light-Level Sensor: Enable low light feature (automatic-on when ambient light is below threshold). Ambient light threshold shall be adaptive utilizing occupant feedback.
3. Detection Coverage (Standard Room): Coverage of 81 sq m, with mounting height of 1.2 m.
4. Dual-technology in-wall sensors are permitted only in Public Access Area (PAA) and General Work Area (GWA).

C. Sensors in CAA:

1. Provide passive infrared (PIR) sensors; ultrasonic or dual technology sensors are prohibited.
2. CAA Restricted: Provide digital control using block diagrams; floor plan configurations are not permitted.
3. CAA Core:

a. Provide basic lighting control by individual suite; control systems are not permitted to cross suite boundaries. Centralized dimming controls, in Section 260934, are not applicable or permitted in these areas.
b. Provide line voltage or analog control only.
c. Reporting of status lights to indicated load status is prohibited.
d. Interconnection to any building automation system, in Section 230905, is prohibited.

2.5 MULTIPOLE CONTACTORS

A. Description: Electrically operated and electrically held, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served.
2. Control-Coil Voltage: Match control power source.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 4 mm2, complying with Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than 1.0 mm2, complying with Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than 2.5 mm2, complying with Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271505 “Communications Horizontal Cabling.”

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260518 “Low-Voltage Electrical Power Conductors and Cables.” Minimum conduit size shall be 13 mm.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounted surge protective devices for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B “Standard for Wire Connectors” or BS 7671:2001 Requirements for Electrical Installations –IEE Wiring Regulations-16th Edition.

3.2 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Label time switches and contactors with unique designation.

3.3 CONTROL LOCATIONS

A. General: Locate controls for appropriate operational controls.

B. Special Scenarios: Locate controls as follows:

1. Main Lobby: Locate in Post 1.
2. Multipurpose Room: Locate in AV Control Booth; if no Booth, contact Project Director/COR for input.
3. American Center: Locate in nearby GWA office area; preferred location in Public Affairs Office if close.
4. Consular Waiting Area: Locate lighting controls, along with integrated window shade controls, in Consular Office area.

5. Gallery/Atrium and Foodservice Area: Locate controls so as to be not readily visible and to facilitate appropriate control.

3.4 FIELD QUALITY CONTROL AND ADJUSTING

A. Perform the following field tests and inspections and prepare test reports:

1. After installing devices and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area.
2. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly signed to accommodate devices and conductors in accordance with OBO Electrical Code.
3. Complete installation and startup checks according to manufacturer’s written instructions.
4. Test for circuit continuity, open, shorts, and other tests as recommended by manufacturer.
5. Check operation of local control devices.
6. Verify that control system features are operational.
7. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Quality Control Demonstration:

1. Demonstrate proper operation of lighting control devices to Architect of Record and to Government representatives identified by Project Director/COR and correct deficiencies or make adjustments as directed.
2. Occupancy Adjustments: Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function of each space.
3. Sensor Location Adjustments: In accordance with design intent, make reasonable minor adjustments to locations of in-wall occupancy sensors to optimize coverage, and to avoid conflicts or problems affecting coverage.

C. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

E. Additional testing and inspecting, at Contractor's expense, may be performed to determine compliance of replaced or additional work with specified requirements.

F. Verify normal operation of each luminaire after installation.

G. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to backup source and retransfer to normal.

3.5 DEMONSTRATION

A. Training: Train Government maintenance personnel on lighting control devices. Provide minimum of one two-hour classroom session and one four-hour demonstrations. Use operation and maintenance manual as training reference, supplemented with additional training materials as required. Refer to Division 01 Section "Closeout Procedures."

1. Topics: Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, and alarms for maintaining lighting control system in coordination with lighting, sensors, and shading device instrumentation and controls. Review control drawings and schematics, and interactions with other systems.
2. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.

END OF SECTION 260924

SECTION 260934 - CENTRALIZED DIMMING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Lighting control module – preset scene main unit.
2. Integrated, multipreset, modular dimming controls.

B. Related Sections include the following:

1. Section 122413 “Window Shading System” for motorized shade system integration with centralized lighting control system.
2. Section 230905 “Instrumentation and Controls for HVAC” for BAS system integration via BACnet with centralized lighting control system.
3. Section 262725 "Wiring Devices" for wall-box dimmers and manual light switches.
4. Section 260924 "Lighting Control Devices" for photoelectric switches, in-wall occupancy sensor switches, and multipole contactors.
5. Section 265105 “Interior Lighting” for LED drivers and fixtures.

1.2 DEFINITIONS

A. Channel: Lighting fixture or group of lighting fixtures controlled simultaneously as single entity. Also known as a "zone."

B. DALI: Digital Addressable Lighting Interface

C. Fade:

1. Fade Override: Ability to temporarily set fade times to zero for all lighting scenes.
2. Fade Rate: Time it takes each channel to arrive at next scene, depending on degree of change in lighting level.
3. Fade Time: Time it takes channel to fade from one lighting scene to another.

D. LED: Light-emitting diode.

E. NRTL: Nationally recognized testing laboratory.

F. Scene: Lighting effect created by adjusting several channels of lighting to desired intensity.

G. Wall-Box Dimmer: Self-contained dimmer that fits into switch box.

1.3 SYSTEM PERFORMANCE

A. Provide complete system with controls indicated on control diagrams on Construction Drawings. Provide lighting control matrix in accordance with room type.

B. Provide centralized lighting control system with graphical floorplan software for Public Access Area (PAA) and General Work Area (GWA).

C. Controlled Access Area (CAA):

1. Provide centralized lighting control system with floorplan software represented in grid format with area name only for Controlled Access Area (CAA). CAA centralized lighting control system shall be separate, self-contained system, and not integrated with GWA centralized lighting control system.
2. Provide stand-alone lighting control solution for CAA Core.
3. Refer to requirements for wired sensors at CAA in Article on INTEGRATED, MULTI-PRESET, MODULAR DIMMING.

D. Wireless lighting controls are prohibited.

E. Centralized lighting control solution shall be able to control all LED lighting sources from single software program, including switching, 0-10V, digital, and tunable white fixtures.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For dimming controls, include dimensions, features, characteristics, and ratings.
2. Device plates and plate color and material.
3. Sound data including results of operational tests of dimming controls.
4. For occupancy/vacancy sensors, include detailed basic motion detection coverage range diagrams
5. Operational documentation for software and firmware, including manufacturer's security statement indicating lighting control system conforms to most current NIST Framework requirements.
6. Identify compliance with performance requirements in Drawings and Specifications.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.

4. System schematic indicating component interconnections. Include requirements for interface with other systems, such as BAS and motorized shades, as required per Project.
5. Sequence of Operation Report for each area/room type.

C. Samples for Initial Selection: For units with factory-applied color finishes and technical features for flush-mounting, dimming control station faceplates.

D. Samples for Verification: Manufacturer's standard sizes for flush-mounting, dimming control station faceplates.

E. Qualifications:

1. Manufacturer in accordance with Article on QUALITY ASSURANCE.
2. Service Start-Up Engineer: Manufacturer’s certificate.

F. Field quality-control test reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

G. Operation and Maintenance Data: For dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals. Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals. In addition to items specified in Division 01 Section " Operation and Maintenance Data," include the following:

1. Software manuals.
2. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
3. Operation of adjustable zone controls.
4. Testing and adjusting of panic and emergency power features.

H. Warranties: Submit sample of manufacturer’s Warranty as specified under Article on WARRANTY.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain dimming controls from single source with total responsibility for compatibility of lighting control system components specified in this Section and Section 260924 "Lighting Control Devices" and Section 265105 “Interior Lighting.”

B. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

C. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

D. Manufacturer Qualifications:

1. Company with not less than ten years of experience manufacturing lighting control systems of similar complexity to specified system.
2. Registered to ISO 9001, including in-house engineering for product design activities.
3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.
4. Capable of providing onsite service support for Project during construction and post-occupancy.
5. NIST 800-171 Program certified by third-party auditor that includes dedicated physical space and network to properly handle and safeguard SBU documents.

E. Service Start-Up Engineer: Certified by manufacturer as capable of performing start-up in relation to system requirements included in this Section.

1.6 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:

1. Section 122413 “Window Shade System,” as required per Project.
2. Section 230905 “Instrumentation and Controls for HVAC.”
3. Section 260924 "Lighting Control Devices."
4. Section 265105 “Interior Lighting.”

1.7 WARRANTY

A. Control System Component Extended Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace control system materials or workmanship within specified warranty period. Lighting management system computer warranty will be addressed in the project one-year warranty provisions for components and labor.

1. Failure includes, but is not limited to, failure of components due to surge.
2. Failure does not include failure of LED drivers.
3. Warranty Period: Two years from date of Substantial Completion, with eight years for surge damage.
4. Warranty service shall include troubleshooting and diagnosis of associated lighting issues.
5. Response for on-site service when required shall be first available.
6. Warranty shall include telephone technical support available 24 hours per day, 7 days per week, excluding manufacturer holidays.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lighting Controller: Full-size units equal to 10 percent of amount installed for each size indicated, but no fewer than two.
2. Control Stations: Equal to 10 percent of amount installed for each size installed, but no fewer than three.
3. Interfaces and Modules: Equal to 10 percent of amount installed for each type installed, but no fewer than two.
4. Occupancy and Daylight Sensors: Equal to 10 percent of amount installed for each type installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 GENERAL DIMMING DEVICE REQUIREMENTS

A. Line-Voltage Surge Suppression: Factory installed as integral part of 120- and 277-V ac, solid-state dimmers and control panels.

1. Alternative Line-Voltage Surge Suppression: Field-mounting surge suppressors that complies with UL 1449 and with IEEE C62.41, for Category A locations.

B. Compatibility: Dimming control components shall be compatible with other elements of lighting fixture types, drivers, transformers, sensors, and lighting controls.

C. Dimmers and Dimmer Modules: Comply with UL 508.

1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
2. Dimmer or Dimmer-Module Rating: As indicated, but not less than 125 percent of connected load.

D. Design lighting control equipment for minimal 10 year operational life while operating continually at any temperature in ambient temperature range of 0 degrees C to 40 degrees C and 90 percent non-condensing relative humidity.

E. Panic Switch: Include where indicated or required by local authorities having jurisdiction (with confirmation of requirement by OBO/PDCS/DE authority having jurisdiction). Switch operation overrides dimmer settings, and restores lights on connected output circuits to full brightness regardless of settings.

2.2 LIGHTING CONTROL MODULE – PRESET SCENE MAIN UNIT

A. Description: Factory-fabricated equipment providing manual dimming control consisting of wall-box mounted master main unit, with preset lighting control scenes and channel override.

1. Provide preset scene main unit(s) with configuration and quantity of zones as indicated or as required to control loads as indicated. User-programmable channel and scene names with astronomical time clock and programmer interface.

    a. Controls and commands for adjustment of each dimmer-channel setting for each scene change from one preset scene to another.
    b. Master channel raises and lowers lighting level.
    c. Adjustable fade rate for each scene from zero fade to one hour.

2. Able to connect to network lighting control system or function as stand-alone dimmer control, as required per Project.
3. Main unit shall have any wireless or IR sensor functions permanently disabled/removed from unit.
4. Mounting: Single, flush-mounting wall box with manufacturer's standard faceplate.

B. Remote-Control Stations:

1. Numbered push buttons to select scenes.
2. Off switch to turn master station off.
3. On switch turns all scenes of master station to full bright.
4. LED indication lights of light level and scene.
5. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted for operation without altering scene values stored in memory.
6. Allow for easy reprogramming without replacing unit.
7. Replacement of units shall not require reprogramming.
8. Control Wiring: NFPA 70, Class 1 or 2.
9. Mounting: Single, flush-mounting wall box with manufacturer's standard faceplate.

2.3 INTEGRATED, MULTI-PRESET, MODULAR DIMMING CONTROLS

A. Description: Microprocessor-based, solid-state controls; centralized lighting control system.

1. Operation: Automatically changes variable dimmer settings of indicated number of channels simultaneously from one preset scene to another when push button is operated.
2. Electrolytic capacitors shall operate when temperatures are at least 20 degree C below component manufacturer’s maximum temperature rating when device is under fully loaded conditions in 40 degrees C ambient temperature.
3. Load Handling Thyristors, Field Effect Transistors and Isolated Gate Bipolar Transistors: Manufacturer’s maximum current rating minimum two times control’s rate operating current.
4. In-Rush Tolerance: Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer.
5. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
6. Design and test dimmer system to withstand line side surges of 6,000 volts without impairment to performance per ANSI/IEEE C62.41B and C62.41C.

7. Utilize air gap off, activated when user selects “off” at any control to disconnect load from line supply.
8. System shall possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption within 3 seconds.
9. Assign each dimmer load type that will provide proper dimming curve for specific light source.
10. System shall possess ability to have load types assigned per circuit, configured in field.
11. Minimum and maximum light levels shall be user adjustable on circuit by circuit basis.
12. System shall control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable. Incorporate electronic “soft-start” default at initial turn-on that smoothly ramps lights up to appropriate levels within 0.5 seconds.
13. Provide real time cycle by cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage/cycle), frequency shifts (plus or minus 2 Hz change in frequency/second), dynamic harmonics, and line noise.
14. Provide each system with master control and remote-station controls.
15. Each channel shall be configurable to control the following:

    a. Low-voltage lamps.
    b. LED fixtures.

16. Memory: System shall retain presets and fade settings through power failures for at least seven days by retaining physical settings of controls or by on-board, automatically recharged battery.

B. Lighting Controllers:

1. Provide lighting controllers as indicated or as required to control the lighting loads as indicated.
2. Delivered and installed as listed factory-assembled panel.
3. Passively cooled via free-convection, unaided by fans or other means.
4. Connection without interface to wired occupancy sensors and wired daylight sensors.
5. Connects to lighting management hub.
6. Switching/0-10V analog lighting controllers:

    a. Single low voltage dimming module capable of dimming 0-10V analog voltage signal or 10-0V analog voltage signal at Class 2 isolated output signal conforming to IEC 60929.
    b. Rated life of switching relay shall be minimum of 1,000,000 cycles at fully rated 16 amp for all lighting loads.
    c. Utilize air gap off, activated when user selects “off” at any control to disconnect load from line supply.
    d. Controller to integrate up to four individually controlled zones, each with capacity of up to 16 amps of high in-rush lighting load.

7. Digital fixture lighting controller

a. Each low-voltage digital communication link to support up to 64 LED drivers capable of NFPA 70 Class 1 or Class 2 installation.
b. Provides two-way feedback with digital fixtures for energy monitoring, light level status, and driver failure reporting.
c. Provide testing capability using manual override buttons.

C. Lighting Management Hubs:

1. Provided in pre-assembled NEMA listed enclosure with terminal blocks for listed field wiring.
2. Enables light management software to control and monitor compatible LED drivers, power panels, power modules, and motorized shades (if applicable).
3. Integrates control station devices, power panels, motorized shades, preset lighting controls, and external inputs into a single customizable lighting control system with:

a. Distributed architecture provides fault containment. Single hub failure or loss of power does not compromise lights and motorized shades connected to other lighting management hubs.
b. Manual overrides.
c. Automatic control.
d. Central computer control and monitoring.
e. Integration with BAS via BACnet (if applicable to Project).

4. Maintains backup of programming in non-volatile memory capable of lasting more than ten years without power.
5. BACnet Test Laboratory (BTL) listed.

D. Lighting Management System Software

1. Provide system software license and hardware that is designed, tested, manufactured, and warranted by single manufacturer.
2. Windows-based, capable of running on either a central server or remote client over TCP/IP connection.
3. Allows control and monitoring of the following:

a. Area lights can be monitored for on/off status, as well as all lights in an area can be turned on/off or sent to specific light level.
b. Area occupancy can be monitored, as well as area occupancy can be disabled to override occupancy control in case of occupancy sensor problems.
c. Daylight status can be monitored, as well as daylighting can be enabled/disabled.
d. Load shed reduction can be applied to selected areas and triggered via software or BACnet.
e. Scheduling: Monitor and adjust scheduled events and astronomic time clock/
f. Reporting: Provide reporting capability to building manager for energy reports, energy saving by strategy report, activity report, system alert reports, and system diagnostics.

4. Administration Access:

a. Allow new user accounts to be created and existing user accounts to be edited.
b. Area and feature access can be restricted based on login credentials with customized access levels available.

E. Control Stations

1. Provide control stations with configuration as indicated or as required to control loads as indicated.
2. Control stations can be replaced without reprogramming.

F. Wired Sensors

1. Occupancy Sensors

a. Furnished with field-adjustable controls for time delay and sensitivity to override any adaptive features.
b. Furnished with all necessary mounting hardware and instructions.
c. Dual Technology Sensors:

1) These sensor types are permitted only in Public Access Area (PAA) and General Work Area (GWA); prohibited in CAA.
2) Dual technologies used shall be Passive Infrared (PIR) and Ultrasonic.
3) Microphonic technology is prohibited in CAA.

d. CAA and CAA Restricted: Only Passive Infrared (PIR) sensors are permitted.
e. Centralized dimming control is not permitted in CAA Core.
f. See also the Article on SYSTEMS PERFORMANCE regarding system restrictions in CAA.

2. Sensor Power Packs: Provide sensor power packs where required for power connection to sensor.
3. Daylight Sensors

a. Open-loop basis for daylight sensor control scheme.
b. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
c. Provide linear response from 0 to 500 footcandles.

G. Low Voltage Control Interfaces

1. Contact Closure Interfaces: Where contact closures are used to integrate between lighting controls and other building systems

a. Input open circuit voltage shall not exceed 36 volts.
b. Input short circuit current shall not exceed 0.5 mA.
c. Mechanical contact closures shall be dry contact rated.
d. Solid state contact closures: output off state leakage current shall not exceed 50mA, and output on state saturation voltage shall not be less than 2 volts.

e. Contact closure input device shall accept both momentary and maintained contact closures.

2. AC Motor Group Controller shall integrate control of AC motor shades, screens and blinds into preset lighting control system as required by project.
3. Emergency Lighting Interface, as required by project, shall:

a. Provide total system listing to UL924.
b. Sense all three phases of building power.
c. Provide an output to power panels if power on any phase fails and sends all lights controlled by these devices to an emergency light level setting. Lights to return to their previous intensities when normal power is restored.
d. Accept contact closure input from fire alarm control panel.

4. Provide power supplies as indicated or as required to power system devices.

2.4 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 4.0 mm^2 complying with Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

B. Classes 2 and 1.0 mm^2: Comply with Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than 2.5 mm^2, complying with Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271505 “Communication Horizontal Cabling.”

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install equipment in accordance with manufacturer’s installation instructions, and as indicated on Drawings.

B. Define each dimmer’s load type, assign each load to a channel, and set control functions.

C. Mount daylight sensors with constant view of daylight for open loop system. Follow manufacturer’s installation instructions for mounting.

D. Ensure that daylight sensor placement minimizes sensors view of electric light sources. Ceiling mounted and lighting fixture mounted daylight sensors shall not have direct view of lighting fixtures.

E. Sensor locations indicated are diagrammatic. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage, in accordance with manufacturer's recommendations.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260518 " Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be13 mm.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounted surge protective devices for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section on "Identification for Electrical Systems."

B. Label each dimmer module with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

1. For PAA and GWA, factory-authorized service representative may be local, non-US citizen.
2. For CAA, factory-authorized service representative shall be US citizen. Cleared escort may be required.

B. Perform the following field tests and inspections:

1. Continuity tests of circuits.
2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

    a. Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

3. Emergency Power Transfer: Test listed functions.

C. Remove and replace malfunctioning dimming control components and retest as specified above.

D. Additional testing and inspecting, at Contractor's expense, may be performed to determine compliance of replaced or additional work with specified requirements.

E. Verify normal operation of each luminaire after installation. Verify normal operation of each lighting channel as designed for Project in Specs and Drawings.

F. Test Labeling: After satisfactory completion of tests and inspections, apply label to tested components indicating test results, date, and responsible agency and representative.

3.5 SYSTEM STARTUP

A. Provide services of manufacturer's certified field service engineer to perform system startup.

B. Manufacturer to conduct a minimum of three site visits to ensure proper system installation and operation.

1. Pre-Installation Visit: Review requirements with installer, including system wiring
2. System Startup: Once lighting control system is installed, manufacturer to perform system startup and verify proper system operation, including:

    a. Verify connection of power wiring, load circuits, and location of controls.
    b. Energize lighting management hubs and install lighting management software.
    c. Address all system devices.
    d. Verify system operation control by control.
    e. Configure fixture groupings for wall controls, daylight sensors, and occupancy sensors.
    f. Provide initial rough calibration of sensors
    g. Obtain sign-off on system functions.

3. System Training: Train OBO Rep on system capabilities, operation, and maintenance. See "DEMONSTRATION" for more details.

C. Include costs for lighting control system manufacturer to visit site at six months and 12 months after system startup to fine-tune sensors and evaluate system usage to make efficiency improvements that will fit with the current use of the facility.

3.6 DEMONSTRATION

A. Engage factory-authorized service representative to train Government maintenance personnel on dimming controls.

1. Provide minimum of one two-hour classroom session and one four-hour demonstration.
2. Use operation and maintenance manual as training reference, supplemented with additional training materials as required. Refer to Division 01 Section "Closeout Procedures."
3. Topics: Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up, and programming, and alarms for maintaining lighting control system in coordination with lighting, sensors, and shading device instrumentation and controls. Review control drawings and schematics, and interactions with other systems.

END OF SECTION 260934

SECTION 261214 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries rated from 601 V up to 35 kV:

1. Dry-type distribution and power transformers.
2. Pad-mounted, liquid-filled transformers.

B. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete.”
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety,” including for electrical safety accessories.
3. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
4. Section 260525 “Grounding and Bonding for Electrical Systems.”
5. Division 26 Section on Identification for Electrical Systems.”
6. **[Division 26 Section on “Vibration and Seismic Controls for Electrical Systems.”]**
7. Section 260573 “Overcurrent Protective Device Coordination Study.

1.2 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

B. Shop Drawings: Diagram power signal and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Underground primary and secondary conduit stub-up location.
2. Dimensioned concrete base, outline of transformer, and required clearances.
3. Ground rod and grounding cable locations.

D. Qualification Data: For testing agency.

E. Field quality-control test reports including Power-Factor Tests, Insulation Resistance Tests, and Insulation Power Factor (Doble) Tests. Final test reports shall be provided to the Project Director/COR for forwarding to OBO/PDCS/DE/EE for approval, and to OBO/CFSM/FAC for inclusion in the Maintenance Database. Refer to Article on FIELD QUALITY CONTROL. Identify the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

F. Certifications:

1. PCBs in Oil-Filled Units: As applicable, certification that, in accordance with OBO Building Code Section 414, the oil contains no PCBs; see Article on QUALIFICATION TESTING.
2. Certification of compliance with NETA ATS, Section 7.2 test parameters; see Article on FIELD QUALITY CONTROL.

G. Follow-up service reports in accordance with Article on FOLLOW-UP SERVICE.

1. Record of Infrared Scanning: Prepare certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

H. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1. Include safety Standard Operating Procedures (SOP), including de-energization and isolation procedures.

1.4 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA) or that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

B. Comply with ANSI C57.12.28, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80.

C. Comply with requirements of the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project

Director/COR based upon input from OBO/PDCS/DE/EE, and marked for the intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.6 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:

1. Altitudes above 1000 m.
2. Exposure to fumes, vapors, or dust.
3. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
4. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
5. Exposure to excessively high or low temperatures.
6. Unusual transportation or storage conditions.
7. Unusual grounding-resistance conditions.

B. Lightning and Surge Protection:

1. Main transformers serving compound buildings shall have distribution class lightning arresters on primary side, and surge protectors on secondary side of transformer.
2. Provide surge protection at service entrance to each building.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 “Cast-in-Place Concrete.”

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

1.8 QUALIFICATION TESTING

A. Expand transformer manufacturer’s standard tests to include; insulation power factor (Doble) tests, insulation oil tests, and dielectric tests. For oil-filled units manufacturer shall certify that, in accordance with OBO Building Code Section 414, oil contains no PCBs, and shall affix label to that effect on transformer tank and on each oil drum containing insulating oil.

B. Added oil condition (acidity, water, power factor, dissolved gas, and dielectric), and insulation power factor test (Doble Test). Maximum acceptable insulation power factor test value is five percent. Tests shall be conducted in accordance with IEEE C57.12.90, IEEE Std. 62, ASTM D 3612, and ASTM D 3487. Manufacturer shall certify that insulating oil contains no PCBs, and shall affix label to that effect on transformer tank, and on each oil drum containing insulating oil.

PART 2 - PRODUCTS

2.1 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

A. Description: ANSI C57.12.13, IEEE C57.12.00, IEEE C57.12.22 IEEE C57.12.26, pad-mounted, 2-winding transformers. Stainless-steel tank base and cabinet.

B. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117; or less- flammable type, fire-resistant biodegradable seed oil (Envirotemp FR3 or equal).

C. Insulation Temperature Rise: 80 deg C when operated at rated kVA output in 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in average ambient temperature of 30 deg C over 24 hours with maximum ambient temperature of 40 deg C, without loss of service life expectancy.

D. Basic Impulse Level: 95 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, two above and two below rated medium-voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. Medium-Voltage Switch: Make-and-latch rating based on calculated short circuit available, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: Fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.

1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
2. Internal liquid-immersed cartridge fuses.
3. Bay-O-Net liquid-immersed fuses which are externally replaceable without opening transformer tank.
4. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
5. Bay-O-Net liquid-immersed current-limiting fuses which are externally replaceable without opening transformer tank.

H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within medium-voltage compartment. Transformers shall have three arresters for radial-feed circuits.

I. Medium-Voltage Terminations and Equipment: Live front with externally clamped porcelain bushings and cable connectors suitable for terminating primary cable.

J. Medium-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

1. Bushing-Well Inserts: One for each medium-voltage bushing well.

2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
3. Parking Stands: One for each medium-voltage bushing well.
4. Portable Insulated Bushings: Arranged for parking insulated, medium-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

K. Accessories:

1. Drain Valve 25 mm, with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage current transformers.
7. Mounting provisions for low-voltage potential transformers.

8. Busway terminal connection at low-voltage compartment.
9. Alarm contacts for gages and thermometer listed above.

L. Size transformer according to that indicated on Drawings or size calculations in accordance with OBO Electrical Code Chapter 2. If size must be adjusted to accommodate load different from that in calculations, provide 20 percent spare capacity over actual demand. Include provisions for future addition of fans to extend capacity 20 percent beyond self-cooled OA rating for future growth.

M. Include provisions for future addition of fans to extend capacity 20 percent beyond self-cooled OA rating for future growth.

N. Transformer impedance should be selected to limit fault current to 65kA.

2.2 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section on "Identification for Electrical Systems."

2.3 SOURCE QUALITY CONTROL

A. Factory Tests:

1. General: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI and IEEE Standards.
2. Perform the following factory-certified tests on each transformer:

   a. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
   b. Ratios on rated-voltage connection and on tap extreme connections.
   c. Polarity and phase relation on rated-voltage connection.
   d. No-load loss at rated voltage on rated-voltage connection.
   e. Excitation current at rated voltage on rated-voltage connection.
   f. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
   g. Applied potential.
   h. Induced potential.

   i. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.

      1) Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

   j. The Government, at its option, may witness all required factory tests. Notify Project Director/COR at least 14 days before date of tests and indicate their approximate duration.

2.4 COILS

A. For transformers to be installed in high fault current areas, aluminum and sheet windings should be avoided.

2.5 INSULATING OIL

A. Neutralization Number shall not be greater than 0.03 gm KOH/ml when measured in accordance with ASTM D 974. Emulsified water shall not exceed 25ppm at 20 deg C. When measured in accordance with ASTM D 1553. Power factor shall not exceed 0.5 percent at 20 deg C when measured in accordance with ASTM D 924.

2.6 AVR AND MEDIUM VOLTAGE TRANSFORMERS

A. AVR and Medium Voltage Transformer Configurations: Without exception, all medium voltage automatic voltage regulators shall be delta connected. Without exception, all medium voltage transformers shall have delta connected primaries and wye connected secondaries.

2.7 PAINTING

A. For all outdoor applications and all indoor applications in harsh environment refer to Division 09 Section on “High Performance Coatings.” After fabrication, all exposed ferrous metal surfaces of transformer and component equipment shall be cleaned and painted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Section 260525 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 10 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on concrete bases.

1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."
2. Construct concrete bases of dimensions indicated, but not less than 100 mm larger in both directions and 100 mm high.
3. Use 20.7-MPa , 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 450-mm centers around full perimeter of base.
5. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and the OBO Electrical Code.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section on "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2.
4. Test and adjust controls and safeties.

B. Upon satisfactory completion of insulation resistance test, perform insulation power factor test and an excitation test on transformer windings. Added oil tests to be performed after electrical tests of the transformer. Transformer shall not be energized until recorded test data have been approved by Project Director/COR.

1. Power Factor Testing: For transformer rated under 100KVA and less than 4160 volts on both primary and secondaries, power factor testing is optional acceptance test. Transformers shall be tested in accordance with IEEE Std 62.

2. Dielectric Testing: Liquid filled transformers shall have insulating liquid dielectrically tested after installation and before being energized. Insulating liquid shall be tested in accordance with ASTM D 877, and breakdown voltage shall not be less than 2, 5, or 8,000 volts as specified.
3. Power Factor Tests: Liquid filled transformers shall have oil power factored at 20 deg C, per ASTM D 924 prior to being energized. Results shall not be greater than 0.5 percent at 20 deg C.
4. Insulation Resistance Tests: Additional industry test specifications.
5. Insulation Power Factor (Double) Tests: Perform insulation power factor test and winding excitation test on transformer windings in accordance with ANSI IEEE C57.12.90. Insulation power factor shall not exceed 0.5 percent for new liquid filled units. New dry type units with power factors up to five percent are still be acceptable.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

D. Acceptance: Final test reports shall be provided to Project Director/COR for forwarding to OBO/CFSM/FAC for inclusion in Maintenance Database.

E. Prepare test reports.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by Government, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During period of normal load cycles as evaluated by Government, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology (NIST) standards, and with chart speed of not less than 25 mm per hour. Voltage unbalance greater than one percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus five percent during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

B. Infrared Scanning: Within 60 days of issuance of Substantial Completion, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.

2. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3.7 DEMONSTRATION AND TRAINING

A. Coordinate with Project Director/COR and post Facility Manger to identify staff, including locally employed staff (LES) maintenance personnel, who may access transformer.

B. Train Government maintenance personnel in the following:

1. Coordinate training with training for other related equipment.
2. Training Topics:

a. Standard Operating Procedures (SOP) described in O&M Data Manual
b. Review data in manufacturer's maintenance manuals, including interface with written SOP.
c. Review safety precautions and use of medium-voltage safety accessories with requirements in Section 260508 "Common Work Results for Electrical, Communications, and Electronic Safety" and Section 260573 "Overcurrent Protective Device Coordination Study."
d. De-energizing procedures to safely de-energize, isolate and lock-out transformers prior to any maintenance or repair work.
e. Features and construction of project equipment.
f. Routine testing and monitoring operations.
g. Interpretation of readings of indicating and alarm devices.
h. Routine inspection procedures.
i. Access control panel to maintain operations log in accordance with procedures of OBO/CFSM/FAC.
j. Removal and replacement of control panel or components.
k. Cleaning of connections and conductors on basis identified by OBO/CFSM/FAC considering input from manufacturer.

C. Schedule training with Project Director/COR with at least seven days' advance notice.

END OF SECTION 261214

SECTION 262214 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.
3. Control and signal transformers.

B. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete.”
2. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
3. Section 260525 “Grounding and Bonding for Electrical Systems.”
4. **[Division 26 Section on “Vibration and Seismic Controls for Electrical Systems.”]**

1.2 SUBMITTALS

A. Product Data Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Wiring and connection diagrams.

C. Source quality-control test reports.

D. Output Settings Reports: Record of tap adjustments specified in Article on ADJUSTING.

1.3 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for the intended use.

B. Comply with IEEE C 57.12.91.

C. Energy-Efficiency:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL

1.4 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 “Cast-in-Place Concrete.”

B. Coordinate installation of wall-mounting and structure-hanging supports.

C. Lightning and Surge Protection:

1. Main transformers serving the Post buildings shall have distribution class lightning arresters on the primary side and surge protectors on the secondary side of the transformer.
2. Provide surge protection at the service entrance to each building.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Source Limitations: Obtain each transformer type from single source from single manufacturer.

B. Description: Factory-assembled and -tested, air-cooled units for 50 or 60-Hz service.

C. Cores: Grain-oriented, non-aging silicon steel.

D. Coils: Continuous windings without splices, except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.2 TRANSFORMERS, GENERAL

A. Transformers: Provide a minimum of 20 percent spare capacity above demand load without requiring fan cooling.

B. Utility (Service) Transformers: Provide either oil filled or encapsulated dry type pad mounted outdoor type incoming commercial service transformers. Prove the transformer with a delta connected primary and a grounded wye connected secondary. The transformer shall be capable of being easily replaced or repaired by the local utility company. Provide encapsulated dry type transformers where there are known problems with PCB contamination in locally available mineral oil.

2.3 DISTRIBUTION TRANSFORMERS

A. Distribution Transformers: Locate distribution transformers adjacent to their associated panel and be sized with 20 percent reserve capacity. Transformers shall be specified with two 2.5 percent FCAN (full capacity above normal) and two 2.5 percent FCBN (full capacity below normal) taps. The transformers shall be indoor, dry, heavy-duty type in NEMA-1 enclosures unless otherwise required. Transformers serving loads with high harmonic content (non-linear loads) shall be K-factor rated to compensate for these effects.

B. Comply with NEMA ST 20, and list and label as complying with UL 1561.

C. [Provide transformers that are internally braced to withstand seismic forces specified in Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."]

D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses: One leg per phase.

E. Coils: Continuous windings without splices except for taps.

1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.

F. Enclosure:

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans. Wiring Compartment: Sized for conduit entry and wiring installation.
3. Finish: Comply with NEMA 250.

G. Wiring Compartment: Sized for conduit entry and wiring installation.

H. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

I. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for “Indoor Corrosion Protection.”

1. Finish Color: ANSI 61 gray.

J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 50 deg C ambient temperature.

K. Taps for Transformers:

1. Transformers Smaller than 3 kVA: One 5 percent tap above normal full capacity.
2. Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity voltage.
3. Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

L. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

M. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.
3. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
4. All power and lighting transformers located in office spaces shall be K-13 rated.

N. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minus 120 dBA minimum at 0.5 to 1.5 kHz; minus 65 dBA minimum at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minus 52 dBA minimum at 1.5 to 10 kHz.

O. Wall Brackets: Manufacturer's standard brackets.

P. [Fungus Proofing: Permanent fungicidal treatment for coil and core.]

Q. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: **[40] <Insert value>** dBA.
2. 9.01 to 30.00 kVA: **[45] <Insert value>** dBA.
3. 30.01 to 50.00 kVA: **[45 dBA for K-factors of 1, 4, and 9] [48 dBA for K-factors of 13 and 20] <Insert dBA>**.

4. 50.01 to 150.00 kVA: **[50 dBA for K-factors of 1, 4, and 9] [53 dBA for K-factors of 13 and 20] <Insert dBA>**.
5. 150.01 to 300.00 kVA: **[55 dBA for K-factors of 1, 4, and 9]** dBA.

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 20 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: ANSI 61 gray.

2.5 CONTROL AND SIGNAL TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty, complying with NEMA ST 20, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

   a. High-voltage to ground.
   b. Low-voltage to ground.
   c. High-voltage to low-voltage.

9. Temperature tests.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls and floors for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. [Brace wall-mounting transformers as specified in Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."]

B. Install floor-mounting transformers level on concrete bases. Construct concrete bases of dimensions indicated, but not less than 100 mm larger in both directions than supported unit and 100 mm high.

1. [Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."]

C. Secure transformer to concrete base according to manufacturer's written instructions.

D. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure

3.4 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

B. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262214

SECTION 262300 – LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes metal-enclosed, low-voltage, power circuit-breaker switchgear rated 1000 V and less for use in AC systems.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communication and Electronic Safety” for facility voltages and safety accessories.
2. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
3. Section 260525 “Grounding and Bonding for Electrical Systems.”
4. **[Division 26 Section on vibration and seismic controls for electrical systems for mounting and anchoring switchgear.]**
5. Section 260573 “Overcurrent Protective Device Coordination Study” for arc flash study, ARMS reduction level or alternative means of compliance for worker safety, and arc flash training.
6. Section 260915 "Electrical Power Monitoring" for interfacing communication and metering requirements.
7. Section 262313 "Paralleling Switchgear".
8. Section 262325 "Power Sequence of Operations.”
9. Section 262412 “Switchboards.”
10. Division 26 Section on fuses for fuses and spare-fuse cabinets.

1.2 SUBMITTALS

A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each type of switchgear and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

   a. Tabulation of installed devices with features and ratings.
   b. Enclosure types and details.
   c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
   d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
   e. Current rating of buses.
   f. Short-time and short-circuit current rating of switchgear assembly.

g. Nameplate legends.
h. Mimic-bus diagram.
i. Utility company's metering provisions with indication of approval by utility company.
j. Arc flash reduction switch.
k. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

E. Field quality-control test reports.

F. Certificates of Compliance: Manufacturer of switchgear shall certify compliance with referenced standards.

G. Qualification data for firms and persons as required in the Part 1 Article on QUALITY ASSURANCE.

1. Testing Agency:
2. Support Services Vendor: Identify vendor firm name and contact, location, distance from project, number of years servicing product line.

H. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.

I. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.3 OWNERSHIP OF PROPRIETARY MATERIAL

A. Government shall retain all rights to software and passwords used for this project.

B. The Government will sign copy of manufacturer’s standard software and firmware licensing agreement as condition of this contract. Such license shall grant use of all programs and

application software to the Government as defined by manufacturer's license agreement, while protecting manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. Licensing agreement shall not preclude use of software by individuals under contract to Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to the Government will be restricted to use on Government's computers, and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation shall become property of Government.

1.4 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

B. Source Limitations: Obtain switchgear through one source from single manufacturer.

C. [Basis of Design: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on specific system indicated. Other manufacturers' products complying with requirements may be considered.]

D. Comply with the OBO Electrical Code (NFPA 70 "National Electrical Code as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

E. Industry Standards: In addition to standards identified elsewhere in this Section, conform to the following:

1. Institute of Electrical and Electronics Engineers (ANSI/IEEE):

a. C37.13 Standard for Low-Voltage AC Power Circuit breakers Used in Enclosures."
b. C37.16 "Switchgear - Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations."
c. C37.50 "Test Procedures of Low-Voltage AC Power Circuit Breakers Used in Enclosures."
d. C37.51 "Conformance Test Procedures of Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies."
e. C57.13 "Standard Requirements for Instrument Transformers."

f. C62.22 "Guide for the Application of Metal-Oxide Surge Arrestors for Alternating-Current Systems)."

2. National Electrical Manufacturers Association (NEMA):

a. SG3 Low Voltage Power Circuit Breakers.
b. SG5 Power Switchgear Assemblies.

3. Underwriters Laboratories, Inc. (UL):

a. 1558 "Metal Enclosed Low-Voltage Power Circuit Breaker Switchgear."

F. Certification: Manufacturer of switchgear shall certify compliance with standards referenced in this Article.

G. Support Service Capability: Manufacturer approved support services Vendor to commission switchgear, and available to provide ongoing maintenance services. Vendor shall be approved by manufacturer. Vendor shall be located within 1500 km (1000 miles) of project site. Vendor shall have performed these services on this product line for at least five years.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Storage: Store in one of the following manners:

1. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
2. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.6 PROJECT CONDITIONS

A. [Installation Pathway: For renovation and system upgrade projects, remove and replace building components and structures to provide pathway for moving switchgear into place.]

B. [Existing Utilities: Do not interrupt utilities serving facilities occupied by the Government or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Project Director/COR not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
2. Indicate method of providing temporary utilities.

3. **Do not proceed with utility interruptions without Project Director/COR's written permission.]**

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding **[40][50][60]** deg C.
2. Altitude: Derate as required if over **<insert altitude>** above sea level.

1.7 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
2. Indicating Lights: Six of each type installed.
3. Touchup Paint: Three containers of paint matching enclosure finish, each 250 mL.

PART 2 - PRODUCTS

2.1 RATINGS

A. Nominal System Voltage: Site Distribution Voltage.

B. Main-Bus Continuous: **[4000] [xxx]** A, or as indicated on Drawings.

C. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

2.2 SWITCHGEAR FEEDERS

A. Circuit breakers shall be a minimum of 800-ampere frame.

B. Breakers/feeders with trip ratings at or under 800 ampere shall be switchboard construction. See Section 262412 “Switchboards.”

2.3 FABRICATION

A. Factory assembled and tested and complying with IEEE C37.20.1 “Metal Enclosed Low-Voltage Power Circuit-Breaker Switchgear.”

B. Indoor Enclosure Material: Steel.

C. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces, complying with IEEE C37.20.1.

D. Extend section barriers between main and tie circuit-breaker compartments to rear of section.

E. Arrange bus isolation barriers to isolate line bus from load bus at each main and tie circuit breaker.

F. Equip circuit-breaker compartments to house drawout-type circuit breakers, and fit with hinged outer doors.

G. Fabricate enclosure with removable, hinged, rear cover panels, secured by captive thumbscrews, to allow access to rear interior of switchgear.

H. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:

1. Utility metering compartment that complies with utility company requirements.
2. Bus transition sections.
3. **[Incoming-line pull sections.]**
4. Hinged front panels for access to metering, accessory, and blank compartments.
5. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.

    a. Set pull box back from front to clear circuit-breaker lifting mechanism.
    b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
    c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

I. Provide bus bars between vertical sections and between compartments. Cable connections are not permitted.

1. Main Phase Bus: Fully rated entire length of assembly; do not taper.

2. Neutral Bus: 100 percent of phase-bus ampacity. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.
3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
4. Phase-and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
5. Use copper for connecting circuit-breaker line to copper bus.
6. Contact Surfaces of Buses: Silver plated.
7. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 6 mm by 50 mm. Extend entire length of the switchgear.
9. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
10. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors.
11. Neutral Disconnect Link: Bolted, uninsulated, 6 mm by 50 mm copper bus, arranged to connect neutral bus to ground bus, if required.
12. Facilitate future extensions from either end of main-phase-neutral and ground bus by providing predrilled bolt-holes and connecting links.
13. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape, or vertical and horizontal busses shall be isolated from cable compartments by glass reinforced polyester barriers.
14. Size busbars to limit temperature rise to 65 deg C above 40 deg C ambient temperature, but shall not exceed 155 amperes per square centimeter.
15. Brace busbars contained in each section to withstand mechanical forces exerted during short circuit conditions. Minimum short circuit bracing shall be 65,000 amperes RMS symmetrical at rated voltage.
16. Completely isolate/insulate entire switchgear bus system with insulated nut covers or grounded metal barriers to preclude accidental contact with live busbars while working in outgoing power cable compartment. Only exposed energized parts in rear power cable compartment shall be outgoing feeder connections.
17. A-B-C type bus arrangement, left-to-right, top-to-bottom, and front-to-rear, as viewed from the front, shall be used throughout. Mount main horizontal bus bars, with all three phases arranged in same vertical plane. Provide full capacity neutral.
18. Identify busbars in each cubicle, both line and load, with adhesive red letters applied to busbar. This identification shall be in each cubicle, as seen from rear cable compartment for all phases, neutral and ground busses in accordance with A-B-C type bus arrangement defined above.
19. Busbar supports shall be non-carbonizing, non-tracking insulators arranged to provide short circuit bracing of 65,000 amperes symmetrical at rated voltage, three-phase.
20. Provide fire-resistive supports to which cable shall be adequately secured and racked within rear compartment.
21. Segregate buses in separate compartment from breaker and feeder cable compartment.
22. Provide main breaker section with vertical barriers between sections extending all the way to rear.
23. Provide main circuit breaker with horizontal isolation barrier or combination of barriers to completely separate bus line from load bus.

24. Provide black vinyl plastic "mimic bus" on front of switchgear depicting current distribution (flow) through each circuit protective device. Secure bus to switchgear enclosure using screws and nuts.
25. From terminals on load side of breaker compartment, extend insulated bus toward back of board to vertical wiring compartment to avoid cables threaded through line bus bars.

J. Fabricate switchgear with ability to remove access covers to facilitate maintenance activities. Facilitate access to inspect device while circuits are energized (e.g., using infrared imaging). Minimum distances to energized circuits shall comply with OSHA standard in CFR 29, Part 1910.333.

2.4 COMPONENTS

A. Instrument Transformers:

1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of
2. 0.3 with burdens of W, X, and Y.
3. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.

B. [Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
2. Switch-selectable digital display of the following:

a. Phase Currents, Each Phase: Plus-or-minus 1 percent.
b. Phase-to-Phase Voltages, Three-Phase: Plus-or-minus 1 percent.
c. Phase-to-Neutral Voltages, Three-Phase: Plus-or-minus 1 percent.
d. Three-Phase Real Power: Plus-or-minus 2 percent.
e. Three-Phase Reactive Power: Plus-or-minus 2 percent.
f. Power Factor: Plus-or-minus 2 percent.
g. Frequency: Plus-or-minus 0.5 percent.
h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus-or-minus 2 percent.
i. Accumulated energy, in megawatt hours (joules), plus-or-minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.]

C. [Analog Instruments: Rectangular, 115-mm square, accurate within 1 percent, semiflush, with antiparallax 250-degree scale and external zero adjustment, complying with ANSI C39.1.

1. Voltmeters: Cover expanded scale range of normal voltage plus 10 percent.

2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6. Watt-Hour Meters: Flush or semiflush type, 5 A, 240 V, three-phase, 3 wire; with three elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

a. Operation: Meter counts and records succession of pulses entering two channels.
b. Housing: Drawout, back-connected case arranged for semiflush mounting.]

D. [Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.]

E. Surge Arresters: Distribution class, metal-oxide-varistor type.

1. Install in cable termination compartments and connect in each phase of circuit.
2. Coordinate rating with circuit voltage.
3. Status and indicator lights shall be visible to operators in room with switchgear.

F. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

G. Provide 10 percent spare circuit breakers installed in switchgear, 20 percent spaces for future breakers, and 20 percent overall spare current carrying capacity for future expansion.

H. [Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.]

I. [Control Power Supply: Control power transformer supplying 220 or 240 V control circuits through secondary disconnect devices. Include the following features:

1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.

a. Secondary windings connected through relay or relays to control bus to effect automatic transfer scheme.
b. Secondary windings connected through internal automatic transfer switch to switchgear control power bus.

3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.]

J. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for 10 mm^2 and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2. Conductors sized according to the NFPA 70 for the duty required.

K. Operating Frequency: U.S. manufactured switchgear is normally designed to operate at 60 Hertz. Where operation at other frequencies is required, consult manufacturer for derating factor. Most manufacturers do not derate for operation at 50 Hertz.

L. Furnish and install power system controller for controlling Essential Bus main breaker, Utility Bus main breaker, HVAC bus main breaker, and tie breaker between Essential and Utility busses.

1. The controller shall utilize programmable logic controller (PLC). Electromagnetic control relays are not acceptable.
2. Provide duplicate “hot standby” PLC in same enclosure as primary. Changeover shall require no more than moving keyed wiring connects and resetting processor but automatic switchover without manual intervention is preferred.
3. Provide 24 hour dedicated battery for system back up.

M. Mechanical Interlock: Provide mechanical interlock where dual feed sources are installed. Mechanical interlock shall limit closing of individual breaker pairs fed from dual sources.

N. Manual/Automatic Operation control: Provide manual control of Switchgear within operating switchgear. Manual control shall override automatic and software control. Remote manual/automatic selection is not permitted.

O. Arc Reduction Maintenance Switch (ARMS): Dual parameter sets that enable trip unit, when activated by maintenance personnel, to automatically lower instantaneous setting, and thereby lower available energy in fault condition (commonly referred to as “maintenance mode”); this causes breaker to trip faster when maintenance is being performed in proximity to energized equipment, thus minimizing arc flash dangers. Refer to Section 260573 “Overcurrent Protective Device Coordination Study” for required arc flash levels or alternative means of compliance for worker safety protection.

P. Each section of the switchgear shall be provided with a thermostatically controlled space heater.

Q. Power for space heaters, work lights and convenience receptacles shall be obtained from a transformer with the switchgear.

2.5 CIRCUIT BREAKERS

A. Construction and Circuit Breakers, General:

1. Switchgear for Operation Above 600 Volts: Provide metal-clad construction. Provide draw-out, vacuum break circuit breakers selected for appropriate voltage, frequency, impulse withstand voltage, and interrupting duty. Use direct current control. Provide copper busbars.
2. Switchgear for Operation at 600 Volts or Below: Provide metal-clad construction consisting of metal-enclosed type construction or molded case circuit breakers. Provide draw-out, air break metal enclosed circuit breakers selected for appropriate voltage, frequency, impulse withstand voltage, and interrupting duty. Alternating current control and solid-state trip units are preferred. Adjustable long-time, short-time, instantaneous, and ground fault sensing shall be selected to coordinate with other system protective devices. Provide copper busbars.

B. Description: Comply with IEEE C37.13 “Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.”

C. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

D. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

1. Normal Closing Speed: Independent of both control and operator.
2. Stored-Energy Mechanism: Electrically charged.
3. Operation counter.

E. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, release mechanism, and the following features:

1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
3. Field-adjustable, time-current characteristics.
4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I2t operation.
7. Pickup Points: Five minimum, for instantaneous-trip functions.
8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:

    a. Three-wire circuit or system.
    b. Four-wire circuit or system.
    c. Four-wire, double-ended substation.

9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

F. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to terminal block in stationary housing.

G. Drawout Features: Circuit-breaker mounting assembly equipped with racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
2. Circuit-Breaker Positioning: Open circuit breaker may be racked to or from connected, test, and disconnected positions only with associated compartment door closed, unless live parts are covered by full dead-front shield. Open circuit breaker may be manually withdrawn to position for removal from structure with door open. Status for connection devices for different positions includes the following:

   a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
   b. Disconnected Position: Primary and secondary devices and ground contact disengaged.

3. Operator shall be able to close and trip circuit breakers electrically as "test" made by using control switches on front. Electrical interlocks shall still work to prevent inadvertent paralleling.

H. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

I. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

J. Operating Handle: One for each circuit breaker capable of manual operation.

K. Electric Close Button: One for each electrically operated circuit breaker.

L. Mechanical Interlocking of Circuit Breakers: Uses mechanical tripping lever or equivalent design and electrical interlocks.

M. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.

N. Undervoltage Trip Devices:

1. Instantaneous, with adjustable pickup voltage.
2. Adjustable time-delay and pickup voltage.

O. Shunt-Trip Devices: Where indicated.

P. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:

1. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
2. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
3. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.
4. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.

Q. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.6 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

1. Racking handle to manually move circuit breaker between connected and disconnected positions.
2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. [Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.]

C. [Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.]

D. Control Cabinets:

1. Provide true redundant controllers for operation to include cabinets, controllers, and independent wiring with manual toggle selector switch between the two controllers.

2. Mount switchgear control components in individual cabinets; cabinet footprint shall be approximately 600 mm (2 feet) deep x 1500 mm (5 feet) high.
3. Cabinet shall consist of two-step rack with electrical connections between battery cells and between rows of cells. Include two flexible connectors with bolted-type terminals for output leads. Battery rack, cell supports, and anchorage shall be rated for seismic requirements of location.
4. Access to cabinet shall be from front, using hinged doors.

E. Spare-Fuse Cabinet: Identified and compartmented steel box, or cabinet with lockable door.

F. Storage for Manual: Include rack or holder, near operating instructions, for copy of maintenance manual.

2.7 DC POWER SYSTEM

A. General:

1. Provide **[48] [24]** VDC power system for control power required for all switchgear device operations.
2. System shall consist of number of batteries, battery cabinets, battery chargers, and other components required for proper operation of this system. Interior UPS units are strictly prohibited.
3. System Requirements: Battery shall have number of cells and ampere-hour capacity based upon initial specific gravity of 1.2 at 25 deg C with electrolyte at normal level, and minimum ambient temperature of 15 deg C. Cycle battery before shipment to guarantee rated capacity upon installation. Arrange battery top operate ungrounded.

B. Battery Charger: Static-type rectifier equipped with automatic regulation, and with provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent, and input-frequency variation of plus or minus 3 Hz. Other features of charge shall include the following:

1. DC ammeter.
2. DC Voltmeter: Maximum error of 5 percent at full-charge; operates with toggle switch to select between battery and charger voltages.
3. Ground Indication: Two appropriately labeled lights shall indicate circuit ground, connected in series between negative and positive terminals, and with midpoint junction connected to ground by normally open push-button contact.
4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.3.3 B per Cell.
5. Charging-Rate Switch: Manually operated switch that provides for transferring to higher charging rate. Charger operates automatically after switch operation until reset.
6. Power Supply and Charging: AC power supply is site standard, subject to +/- 10 percent variation in voltage, and +/- 3 Hz variation in frequency.

a. After loss of AC power supply for any interval, charger shall automatically resume charging battery.
b. Charger shall regulate rate of change to prevent damage due to overload, and to prevent fuses or circuit breakers from opening.

7. Protective Feature: Feature provide current-limiting device or circuit which limits output current to rating of charger, but does not disconnect charger from either battery or AC supply; feature shall protect charger from damage due to overload, including due to short circuit on output terminals.
8. Audible noise shall be less than 70 dBA at 1 meter.

C. Batteries:

1. Battery Type: Sealed, maintenance-free lead acid type.
2. Expected Life: 10-year life when operated and maintained within its specifications.
3. Final Discharge Voltage: 1.75 volts per cell.
4. Nominal Float Voltage: 2.25 volts per cell.
5. Battery Recharge Time: Charger shall have capacity to recharge batteries from 10 percent to 90 percent capacity within 12 hours.
6. Battery Circuit Protection: Protection via fuse or circuit breaker.
7. Nominal Battery Ampere Hour (A.H.) Capacity: **[100] [XX]** A.H.; **[sized to provide proper operation of the gear for at least 48 hours with the anticipated number of breaker operations likely to occur with [YY] commercial power losses and returns.]**
8. System batteries shall be suitable for service at ambient temperature ranging from minus 18 to plus 40 deg C.

2.8 FACTORY TESTING

A. Perform factory test of switchgear.

1. Perform each case identified in Article on SEQUENCE OF OPERATIONS in Section 262315 “Double-Ended Switchgear.”
2. Re-rest all failed test until successful test is achieved.
3. Factory testing shall be witnessed by representative from OBO/PDCS/DE/EE. Provide notification to Project Director/COR within 30 calendar days of scheduled test. Representative from OBO/PDCS/DE/EE may perform factory inspection at that time as well.

2.9 SOFTWARE

A. At project closeout, submit two electronic copies of PLC software, password, operating software platform, and source code to Project Director/COR for distribution to Post Facility Manager and OBO/OPS/FAC/PS. PLC software shall facilitate future modifications to power transfer scheme by Post Facility Manager, and operating software platform shall facilitate future reading of PLC software by programmer.

1. In addition, submit two hardcopy manuals of PLC software and code to Project Director/COR for similar distribution as with software.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable portions of NECA 400.

B. Anchor switchgear assembly to 100-mm (4-inch), channel-iron floor sill embedded in floor or concrete base and attach by bolting.

1. Sills: Select to suit switchgear; level and grout flush into floor or concrete base.
2. **[Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section on vibration and seismic controls for electrical systems for seismic-restraint requirements.]**
3. Concrete Bases: 100-mm (4-inch) high, reinforced, with chamfered edges. Extend base no more than 75 mm (3 inches) in all directions beyond maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section on vibration and seismic controls for electrical systems.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section on identification for electrical systems.

B. Diagram and Instructions - General:

1. Frame and mount under clear acrylic plastic on front of switchgear.

C. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.

D. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

1. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

E. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics, as selected or accepted by Project Director/COR.
3. Color: Contrasting with factory-finish background; as selected or accepted by Project Director/COR from manufacturer's full range.

F. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:

1. Frame size of each circuit breaker.
2. Trip rating for each circuit breaker.
3. Conduit and wire size for each feeder.

3.4 CONNECTIONS

A. Ground equipment according to Chapter 2 of the OBO Electrical Code. Refer to Section 260525 “Grounding and Bonding for Electrical Systems.”

B. Connect wiring according to Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage factory-authorized service representative to perform the following:

1. Inspect switchgear installation, including wiring, components, connections, and equipment.
2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Complete installation and startup checks according to manufacturer's written instructions.

4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
5. Report results in writing.

C. Testing: After installing switchgear and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Perform each electrical test and visual and mechanical inspection identified in NETA ATS. Certify compliance with test parameters.

D. Switchgear: Perform tests and inspections stated in NETA, Section 7.1.

E. Circuit Breakers: Perform tests and inspections stated in NETA, Section 7.6.

1. Primary Injection
2. Secondary Injection

F. Protective Relays: Perform tests and inspections stated in NETA, Section 7.9.

G. Instrument Transformers: Perform tests and inspections stated in NETA, Section 7.10.

H. Metering and Instrumentation: Perform tests and inspections stated in NETA, Section 7.11.

I. Ground-Fault Systems: Perform tests and inspections stated in NETA, Section 7.14.

J. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance. Remove and replace malfunctioning units, and retest as specified above until compliance is demonstrated.

K. Infrared Scanning: Within 60 days of issuance of Substantial Completion, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner. Testing shall include connections and inductive heating of cabling at entrances or where racked in trenches.

1. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
2. Instrument: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Section 260573 "Overcurrent Protective Device Coordination Study."

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 STARTUP SERVICES

A. Engage factory-authorized service representative to perform startup service.

B. Verify that switchgear is installed and connected according to the Contract Documents.

C. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train post maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section “Demonstration and Training.”

1. Train on procedures and schedules for general troubleshooting, servicing, and maintaining equipment and schedules, and for equipment isolation and de-energization procedures.
2. Refer to the Part 3 Article on ARC FLASH TRAINING in Section 260573 “Overcurrent Protective Device Coordination Study” for associated training requirements.
3. Review data in maintenance manuals.
4. Schedule training with the Project Director/COR with at least seven days' advance notice.

END OF SECTION 262300

SECTION 262313 - PARALLELING SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes **[metal-clad][metal enclosed]**, **[low][medium]**-voltage, circuit-breaker switchgear rated **[1000][5000][15000][35000]** V and less, and associated control systems, for paralleling generators on an isolated bus and for distributing power in ac systems.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications and Electronic Safety” for facility voltages and safety accessories.
2. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
3. Section 260525 “Grounding and Bonding for Electrical Systems.”
4. **[Division 26 Section on vibration and seismic controls for electrical systems for mounting and anchoring switchgear.]**
5. Section 260573 “Overcurrent Protective Device Coordination Study” for arc flash study, ARMS reduction level or alternative means of compliance for worker safety, and arc flash training.
6. Section 260915 "Electrical Power Monitoring" for interfacing communication and metering requirements.
7. Section 262300 "Low-Voltage Switchgear."
8. Section 262315 “Double-Ended Switchgear.”
9. Section 262325 “Power Sequence of Operation.”
10. Section 263214 "Engine Generators."
11. **[Division 26 Section “MV switchgear.”]**

C. Where requirements in this Section are in conflict with those in Section 263214 "Engine Generators" and Section 262300 "Low-Voltage Switchgear," the requirements herein shall govern.

1.2 REFERENCES

A. General: In addition to standards identified elsewhere in this Section, conform to the applicable Standards in this Article.

B. Institute of Electrical and Electronics Engineers (IEEE):

1. C37.13, “Standard for Low-Voltage AC Power Circuit breakers Used in Enclosures.”
2. C37.16, “Switchgear - Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.”

3. C37.50 "Test Procedures of Low-Voltage AC Power Circuit Breakers Used in Enclosures."
4. C37.51, "Conformance Test Procedures of Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies."

C. Underwriters Laboratories, Inc. (UL):

1. 1558, "Metal Enclosed Low-Voltage Power Circuit Breaker Switchgear."

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. HMI: Human machine interface.

1.4 SUBMITTALS

A. Product Data: For each type of switchgear and related equipment, include the following:

1. Technical data on features, performance, electrical characteristics, ratings, and finishes.
2. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
3. Features, characteristics, ratings, factory settings, and time-current characteristic curves for individual relays and overcurrent protective devices.
4. Description of sequence of operation for paralleling controls.

B. Shop Drawings: For each type of switchgear and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

a. Tabulation of installed devices with features and ratings.
b. Enclosure types and details.
c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
d. Floor plan drawing showing locations for anchor bolts**[and leveling channels]**.
e. Bus configuration with current rating, size, and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
f. Short-time and short-circuit current rating of switchgear assembly.
g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
h. Nameplate legends.
i. Mimic-bus diagram.
j. Arc flash reduction switch.
k. UL listing for series rating of installed devices.

2. Wiring Diagrams: For switchgear, paralleling control system, and related equipment, include the following:

   a. Power, signal, and control wiring.
   b. Schematic control diagrams.
   c. Diagrams showing connections of component devices and equipment.
   d. Three-line diagrams of current and future circuits showing device terminal numbers and internal diagrams.
   e. Schematic diagrams showing connections to remote devices.

3. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. [Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section on vibration and seismic controls for electrical systems. Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.]

E. Certificates of Compliance: Manufacturer of switchgear shall certify compliance with referenced standards.

F. Qualification Data:

1. Support Services Vendor: Identify vendor firm name and contact, location, distance from project, years and servicing product line.
2. Testing Agency: As required in Article on QUALITY ASSURANCE.

G. Source quality-control test reports.

H. Field quality-control test reports.

I. Updated mimic bus diagram reflecting field changes after final switchgear load connections have been made, for record.

J. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Systems Manual and O&M Data," include the following:

1. Manufacturer's written instructions for sequence of operation.
2. Manufacturer's sample system checklists and log sheets.
3. Manufacturer's written instructions for testing and adjusting relays and overcurrent protective devices.
4. Time-current curves, including selectable ranges for each type of relay and overcurrent protective device.
5. Range and set points for all adjustable time delay functions.

1.5 OWNERSHIP OF PROPRIETARY MATERIAL

A. The Government shall retain all rights to software and passwords used for this project.

B. The Government will sign a copy of manufacturer's standard software and firmware licensing agreement as condition of this contract. Such license shall grant use of all programs and application software to the Government as defined by manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude use of software by individuals under contract to the Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to the Government will be restricted to use on the Government's computers and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation shall become the property of the Government.

1.6 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), or a nationally recognized testing Laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA, the NRTL, or the National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. **[Basis of Design: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated.]**

D. Comply with the OBO Electrical Code (NFPA 70 "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

E. Support Service Capability: Manufacturer approved support services Vendor to commission switchgear and available to provide ongoing maintenance services. Vendor shall be approved by manufacturer. Vendor shall be located within 1500 km (1000 miles) of project site. Vendor shall have performed these services on this product line for at least five years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Storage: Store in one of the following manners:

1. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
2. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.8 PROJECT CONDITIONS

A. [Installation Pathway: For renovation and system upgrade projects, remove and replace building components and structures to provide pathway for moving switchgear into place.]

B. [Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Project Director/COR not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
2. Indicate method of providing temporary utilities.
3. Do not proceed with utility interruptions without Project Director/COR's written permission.]

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding **[40 deg C (104 deg F)] [50 deg C (122 deg F)] [60 deg C (140 deg F)]**.
2. Altitude: Derate as required if over <**Insert elevation**> above sea level.
3. <**Insert unusual service conditions.**>

1.9 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Six of each type and rating used. Include spares for potential transformers, control power circuits and fusible devices. Fuses are specified in Division 26 Section on fuses.
2. Indicating Lights: Six of each type installed.
3. Touchup Paint: Two containers of paint matching enclosure finish, each 250 mL (0.5 pint).

B. Maintenance Tools: Furnish tools and miscellaneous items required for switchgear test, inspection, maintenance, and operation. Include the following:

1. Traveling-type lifting device, rail mounted on top of switchgear and all other items necessary to remove circuit breaker from housing and transport to remote location.
2. Racking handle to move circuit breaker manually between connected and disconnected positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.

PART 2 - PRODUCTS

2.1 GENERATOR PARALLELING MONITOR AND CONTROL SYSTEM

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in to the Work include, but are not limited to, the following:

1. Caterpillar; Engine Div.
2. Emerson; ASCO Power Technologies, LP.
3. GE Zenith Controls.
4. Kohler Co.; Generator Division.
5. Onan Corp.; Cummins Inc.; Industrial Business Group.
6. Russelectric.

B. Individual Generator Control and Monitoring Panel: Provide each generator with a control and monitoring panel that allows the operator to view status and control operation of respective generator. **[Select display items and functional controls may be provided instead by the HMI**

required for the Master Control System subject to specific submittal, review, and approval by OBO.] Provide panel with the following features and characteristics:

1. Generator Metering: 1 percent accuracy class or better.

    a. Ammeter, Voltmeter, Frequency Meter, Wattmeter, Kilowatt-Hour Meter, and Power Factor Meter:

        1) For three-phase and four-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.
        2) Provide switches or other provisions to allow reading of both generator and bus voltages and frequencies from this metering set.

    b. Synchroscope and "Generator Set Synchronized" Indication:

        1) Provide lamp or LED indication of synchronization.
        2) Provide electronic synchronization control.

    c. Engine run-time meter, start counter, rpm meter, and battery voltage meter.
    d. Engine oil temperature gage and engine coolant temperature gage.

2. Generator Protective and Control Switches: Provide oiltight, industrial-grade switches in generator control and monitoring panel.

    a. Mode Selector Switch (Run or Manual/Off/Auto):

        1) "Run or Manual" mode to start and accelerate unit to rated speed and voltage, but not close paralleling circuit breaker.
        2) "Off" mode to prevent generator from starting or to immediately shutdown generator if running.
        3) "Auto" mode to allow generator to start on receipt of remote start signal.

    b. Circuit-Breaker Trip/Close Switch: Interlocked with system control so that circuit-breaker closure is impossible unless the following occurs:

        1) Mode selector switch is in "Run or Manual" position.
        2) Generator set is synchronized with system bus.

    c. Control/reset with flashing lamp or error message to indicate generator is locked out due to fault condition.
    d. Lamp test push button to simultaneously test all lamps on panel.
    e. [Control Panel Illumination: DC lamps to illuminate panel when lighting from surrounding environment is not available.]
    f. Emergency Stop Push Button: Red mushroom-head switch maintaining its position until manually reset.
    g. Voltage and Frequency Raise/Lower Controls:

        1) Allow plus/minus 5 percent adjustment when generator set is operating but not paralleled.

3. Generator Protective and Control Devices: Solid-state industrial relays, integrated microprocessor-based control devices, and other accessories and devices located either in generator control and monitoring panel or in switchgear control section to provide the following features and functions:

   a. Kilowatt Load Sharing Control:

      1) Operates engine governors during synchronizing and provides isochronous load sharing when paralleled.
      2) Allows generator set to ramp up to kilowatt load level signaled by system master controller.

   b. Load-Demand Governing Control:

      1) Causes generator set to ramp down to zero load when signaled to shut down in load-demand mode.
      2) Causes generator set to ramp up to a proportional share of total bus load.

   c. Kilovolt Ampere Rating Load Sharing Control:

      1) Operates alternator excitation system while generator set is paralleled.
      2) Causes sharing of reactive load among all generator sets to within 1 percent of equal levels without voltage drop.

   d. Sync-Check and Paralleling Monitor and Control:

      1) Monitors and verifies that generator set has reached 90 percent of nominal voltage and frequency before closing to bus.
      2) Prevents out-of-phase paralleling if two or more generator sets reach operating conditions simultaneously, by sending "inhibit" signal to sets not designated by system as "first to close to bus."
      3) Recognizes failure of "first-to-close" generator set and signals system paralleling to continue.
      4) Prevents out-of-phase closure to bus due to errant manual or automatic operation of synchronizer.

   e. Synchronizer Control:

      1) Adjusts engine governor to match voltage, frequency, and phase angle of paralleling bus.
      2) Maintains generator set voltage within 1 percent of bus voltage, and phase angle within 20 electrical degrees of paralleling bus for 0.5 seconds before circuit-breaker closing.
      3) Provides "fail-to-synchronize time delay" adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down generator set on failure condition.

   f. Reverse Power Monitor and Control:

1) Prevents sustained reverse power flow in generator set.
2) Trips generator circuit breaker and initiates generator set shutdown when reverse power condition exceeds 10 percent of generator set kilowatt rating for three seconds or with settings as recommended by generator set manufacturer.

g. Phase Rotation Monitor and Control:

1) Verifies generator set and paralleling bus phase rotation match prior to closing paralleling circuit breaker.

h. Electronic Alternator Overcurrent Alarm and Shutdown Control:

1) Monitors current flow at generator set output terminals.
2) Initiates alarm when load current on generator set **[is more than [110][105] percent of rated current for more than [60][X] seconds][reaches a state requiring warning]**.
3) Provides overcurrent shutdown function matched to thermal damage curve of alternator. Provide without instantaneous-trip function.

i. Electronic Alternator Short-Circuit Protection:

1) Provides shutdown when combined time/load current approaches thermal damage curve of alternator. Provide without instantaneous-trip function.

j. Loss of Excitation Monitor:

1) Initiates alarm when sensing loss of excitation to alternator while paralleled to system bus.

k. Generator Set Start Contacts: Redundant system, 10 A at 32-V dc.
l. Cool-Down Time-Delay Control: Adjustable, 0 to 600 seconds.
m. Start Time-Delay Control: Adjustable, 0 to 300 seconds.
n. Paralleling Circuit-Breaker Monitor and Control:

1) Monitors circuit-breaker auxiliary contacts.
2) Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).
3) Trips open and locks out paralleling circuit breaker upon paralleling circuit breaker failure to close, until manually reset.

4. Engine Protection and Local Annunciation:

a. Provide annunciation and shutdown control modules for alarms indicated.
b. Provide visual alarm status indicator and alarm horn with silence/acknowledge push button on generator control and monitoring panel.
c. Annunciate the following conditions:

1) Status, Light Only (Nonlatching):

a) Generator engine control switch not in auto (red).
b) Generator engine control switch in auto (green).
c) Emergency mode (red).
d) Generator circuit breaker closed (red).
e) Generator circuit breaker open (green).
f) Engine stopped (green).
g) Engine running (red).
h) Engine cool-down (amber).

2) Pre-Alarm, Light and Horn (Nonlatching):

a) Pre-high coolant temperature (amber).
b) Pre-low oil pressure (amber).
c) Low coolant temperature (amber).
d) Engine low battery (amber).
e) Engine low fuel (amber).
f) Generator fails to synchronize (amber).

3) Shutdown Alarm, Light and Horn (Latching):

a) Engine overcrank (red).
b) Engine overspeed (red).
c) Engine low oil pressure (red).
d) Engine high coolant temperature (red).
e) Engine low coolant level (red).
f) Engine remote emergency shutdown (red).
g) Generator circuit breaker tripped (red).
h) Generator loss of field (red).
i) Generator reverse power (red).
j) Generator undervoltage (red).
k) Generator overvoltage (red).
l) Generator underfrequency (red).
m) Generator overfrequency (red).

C. Master Control System and Monitoring Equipment: Paralleling and monitoring equipment, components, and accessories for multiple generators with the following features and characteristics:

1. Components and devices shall be mounted in the switchgear control section of the switchgear lineup.
2. Paralleled System Metering: 1 percent accuracy class or better to monitor total output of generator bus.

a. Ammeter, voltmeter, frequency meter, wattmeter, kilowatt-hour meter, power factor meter, kilovolt ampere, kilovolt ampere rating, and kilowatt demand meters.

1) For three-phase/four-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.

2) Display all functions on the HMI device.

3. Full-Color HMI Device: Touchscreen with minimum diagonal length of 43 cm. (17 inches).

a. Allows operator to monitor and control the complete system of paralleled generator sets.
b. Screens shall include the following:

1) Main Menu: Include date, time, and system status messages with screen push buttons to access one-line diagram, system controls, load controls, alarms, bus metering, and individual generator set data.
2) One-Line Diagram Screen: Depicting system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators. Indicate the following minimum system conditions:

a) Generator sets, buses, and paralleling circuit breakers energized/de-energized.
b) Generator set mode (run or manual/off/auto/cooldown).
c) Generator set status (normal/warning/shutdown/load-demand/stop).
d) Paralleling circuit-breaker status (open/closed/tripped).
e) Bus conditions (energized/de-energized).
f) Provide access to other screens.

3) AC Metering Screen: Displays the following minimum meter data for the paralleling bus:

a) Phase volts and amperes, kilowatts, kilovolt amperes, power factor, frequency.
b) Kilowatt hour usage total with daily, weekly, and monthly recording options.
c) Real-time trend chart for system kilowatts and volts updated on not less than one-second intervals.

4) Generator Set Control Screen: Provides control over individual generator sets from master system control panel. Includes the following minimum functions:

a) Generator manual start/stop control (functional only when generator set mounted control switch is in "Auto" position).
b) Generator set alarm reset.
c) Manual paralleling and circuit-breaker controls.

5) Generator Set Data Display Screen: Provide the following minimum parameters:

a) Engine speed, oil pressure and temperature, coolant temperature, and engine operating hours.

b) Three-phase voltage and current, kilowatt, power factor, and kilowatt hour.
c) Generator control switch position and paralleling circuit-breaker position.
d) All generator set alarms.

6) System Control Screen: Password protected and with the following minimum functions:

a) System Test Modes: Test with load/test without load/normal/retransfer time-delay override.
b) Test with Load: Starts and synchronizes generator sets on paralleling bus; all loads are transferred to bus.
c) Test without Load: Starts and synchronizes generator sets on paralleling bus but does not transfer loads to bus.
d) Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

7) Load-Demand (or Gen-Demand) Control Screen: Monitors total load on system bus and controls number of generator sets running so that capacity tracks load demand.

a) Load-Demand Control: On/off.
b) Load-Demand Pickup Set Point: Adjustable from 90 to 40 percent in 5 percent increments.
c) Load-Demand Dropout Set Point: Adjustable from 20 to 70 percent in 5 percent increments.

8) Manual Load Control Screen: Allows operator to manually add or delete generator sets from paralleled system in response to system load parameters.

a) Indication of system available in kilowatts and amperes.
b) Control functions allow manual addition/removal of generator sets on system, and activation of load-shed/load-restore functions.

9) Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:

a) Assigns "load-add sequence priority" to each load control relay with designation for relay operation after a set number of generator sets are online.
b) Assigns "load-shed sequence priority" to each load control relay with designation for relay operation depending on number of generator sets online.

10) Alarm Summary and Run Report Screen:

a) Lists most recent alarm conditions and status changes.

b) Lists a minimum of the most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.
c) Lists start time and date and stop time and date for individual generator sets.

4. Solid-State System Status Panel:

a. Provides visual alarm status indicator and alarm horn with silence/acknowledge push button. May be integrated into the HMI or be a stand alone panel.
b. Annunciates the following conditions:

1) Status, Light Only:

a) Running Status: Display generator set number and "green" running-status light.
b) Load-demand mode (green).
c) Priority Load shed Status: Display load number and "green" on-status light.
d) System test (green).
e) Normal source available (green).
f) Connected to normal (green).
g) Generator source available (green).
h) Connected to generator source (green).

2) Status, Light and Alarm:

a) Load-Shed Level Status: Displays load number and load-shed, status light.
b) Generator Alarm Status: Displays generator number and "Check Generator" status light.
c) Controller malfunction (red).
d) Check station battery (red).
e) Bus overload (red).
f) System not in auto (red).

D. General Description of System Operation. See spec Section 262325 “Power Sequence of Operation” for more details.

2.2 SWITCHGEAR

A. Refer to Section **[262300 “Low-Voltage Switchgear”][Division 26 Section “MV Switchgear”]** for requirements for **[low][medium]** voltage, **[metal-clad][metal enclosed]**, circuit breakers, instruments, surge protection devices, provisions, ARMS, associated components, mimic bus, and control components. Provide additional features as indicated below.

B. Mechanical Interlock: Provide mechanical interlock where dual feed sources are installed. Mechanical interlock shall limit closing of individual breaker pairs fed from dual sources.

C. Spare Generator Connection: Switchgear shall have spare control breaker to connect portable temporary generator.

1. Provide connection point for cabling for power and control.
2. Ensure that paralleling switchgear controls are capable of operating with portable generator.
3. Size breaker, conductors and cabling so that they are two times size required for single facility generator.
4. Operational Interface: A qualified engineer shall analyze two operational situations below, and coordinate system design accordingly:

a. Synchronize with Facility Generators: If portable generator is suitable for paralleling with facility generators, then switchgear controls shall operate generator for synchronization.
b. Operate as Stand-Alone Generator: However, if generator is not capable of synchronizing with facility generators, then system shall be developed with procedures to load-shed non-critical loads to operate system on single portable generator.

2.1 FACTORY TESTING

A. Perform factory test of switchgear.

1. Perform each case identified in Article on SEQUENCE OF OPERATIONS in Section 262325 “Power Sequence of Operation.”
2. Re-test all failed test until successful test is achieved.
3. Factory testing may be witness by Government representative. Provide notification to Project Director/COR within 30 days of scheduled test. Government representative may perform factory inspection at that time as well.

2.2 SOFTWARE

A. At project closeout, submit two electronic copies of PLC software, password, operating software platform, and source code to Project Director/COR for distribution to Post Facility Manager and OBO/CFSM/FM/PS. The PLC software will facilitate future modifications to power transfer scheme by Post Facility Manager, and the operating software platform will facilitate future reading of PLC software by programmer.

1. In addition, submit two hardcopy manuals of PLC software and code to Project Director/COR for similar distribution.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's installation instructions and with applicable portions of NECA **[400 for LV switchboards][430 for MV switchgear]**.

B. Anchor switchgear assembly to 100-mm (4-inch) channel-iron embedded in concrete base and attach by bolting.

1. Sills: Select to suit switchgear; level and grout flush into concrete base.
2. **[Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section on vibration and seismic controls for electrical systems for seismic-restraint requirements.]**
3. Concrete Bases: Install in accordance with Section 260508 "Common Work Results for Electrical, Communications, and Electronic Safety."

C. Surge Protection Devices:

1. Install in cable termination compartments and connect in each phase of circuit per manufacturer's design and recommendations.
2. Place surge protection devices so status and indicator lights are visible to operators in room.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section on identification for electrical systems and the applicable Division 26 switchgear specification.

B. Diagram and Operations and Maintenance Manual storage:

1. Frame and mount under clear acrylic plastic on front of switchgear a System Single Line Diagram: Depict power sources, feeders, major distribution components, and major centers.

2. Storage for Operations and Maintenance Manual: Include a rack or holder or place behind a compartment door for a copy of the Paralleling System Operations and Maintenance manual.

3.4 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to **Section [260518 "Low-Voltage Electrical Power Conductors and Cables.] [Division 26 Section on MV conductor and cables.]** Install and relieve any unacceptable stress on conductor terminations by using appropriate mechanical support mechanisms and devices as recommended by the manufacturer.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Complete installation and startup checks according to manufacturer's written instructions.
4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
5. Report results in writing

C. Testing: After installing switchgear and after electrical circuitry has been energized, demonstrate capability of switchgears and compliance with requirements.

1. Perform each electrical test and each visual and mechanical inspection in accordance with InterNational Electrical Testing Association (ANSI/NETA) "Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems (ATS)." Certify compliance with test parameters. Perform NETA ATS tests and inspections for each of the following NETA ATS categories:

a. Switchgear: Perform tests and inspections stated in NETA ATS Section 7.1.
b. Circuit Breakers: Perform tests and inspections stated in NETA ATS Section 7.6.

1) Primary Injection
2) Secondary Injection

c. Protective Relays: Perform tests and inspections stated in NETA ATS Section 7.9.
d. Instrument Transformers: Perform tests and inspections stated in NETA ATS Section 7.10.
e. Metering and Instrumentation: Perform tests and inspections stated in NETA ATS Section 7.11.
f. Ground-Fault Systems: Perform tests and inspections stated in NETA ATS Section 7.14.

2. Correct malfunctioning units on-site where possible, and retest as specified above until compliance is demonstrated.

D. Infrared Scanning: Within 60 days of issuance of Substantial Completion, perform an infrared scan on each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner. Testing shall include connections and inductive heating of cabling at entrances or where racked in trenches.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to results in Section 260573 "Overcurrent Protective Device Coordination Study."

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train post maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."

1. Train on procedures and schedules for general troubleshooting, servicing, and maintaining equipment and schedules, and for equipment isolation and de-energization procedures.
2. Refer to Article on ARC FLASH TRAINING in Section 260573 “Overcurrent Protective Device Coordination Study” for associated training requirements.
3. Review data in Operation and Maintenance manuals.
4. Schedule training with the Project Director/COR with at least seven days' advance notice.

END OF SECTION 262313

SECTION 262315 - DOUBLE-ENDED SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes metal-enclosed, low-voltage, power circuit-breaker double-ended switchgear rated 1000 V and less for use in ac systems.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications and Electronic Safety” for facility voltages and safety accessories.
2. **[Division 26 Section on vibration and seismic controls for electrical systems for mounting and anchoring switchgear.]**
3. Section 260573 “Overcurrent Protective Device Coordination Study” for arc flash study, ARMS reduction level or alternative means of compliance for worker safety, and arc flash training.
4. Section 260915 “Electrical Power Monitoring.”
5. **[Section 262313 “Paralleling Switchgear.”]**
6. Section 262325 “Power Sequence of Operation.”
7. Section 262412 “Switchboards.”
8. Division 26 Section on fuses for fuses and spare-fuse cabinets.
9. **[Section 263214 “Engine Generators.”]**
10. Section 263237 “Resistive Load Banks.”

1.2 SUBMITTALS

A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For the double-ended switchgear and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. Enclosure types and details.
   b. Nameplate legends.
   c. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
   d. Current rating of buses.
   e. Short-time and short-circuit current rating of switchgear assembly.
   f. Mimic-bus diagram.

g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
h. Overall dimensions of double-ended switchgear.
i. Front and section views of double-ended switchgear.
j. Internal wiring diagrams.
k. Electrical characteristics of equipment, including ampere ratings of buses, maximum short circuit withstand ratings and control voltages.
l. Approximate weight of each section of double-ended switchgear and total weight with information required for design of supports and housekeeping pad.
m. Double-ended switchgear elevation with dimensions including available conduit space for each section of double-ended switchgear, front view shipping splits, mounting details and wiring details.
n. Double-ended switchgear device layouts.
o. An anchor bolt plan with dimensions.
p. Isometric of bussing showing ampacities for vertical and horizontal busses.
q. Bus bracing of each section.
r. Arc flash reduction switch.

2. Wiring Diagrams: Provide required wiring diagrams to indicate required power, signal, and control wiring. Wiring diagrams shall differentiate between manufacturer-installed and field-installed wiring details. In addition, wiring diagrams shall show all required relays, controllers, interlocks, and interface devices needed for proper operation of power distribution system. Refer to other Division 26 Sections for interface requirements with this switchgear.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show double-ended switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Qualification data for testing agency as required in Article on QUALITY ASSURANCE.

G. Updated mimic-bus diagram reflecting field changes after final double-ended switchgear load connections have been made, for record.

H. Maintenance Data: For the double-ended switchgear and components to include in maintenance manuals. In addition to requirements specified in Division 01 include the following:

1. Routine maintenance requirements for double-ended switchgear and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

I. Maintenance and Operating Manuals:

1. Contents:

a. Each item of equipment and each system: Include description of unit or system, and component parts. Give function, normal operating characteristics, and limiting conditions. Include performance curves, commercial number of replaceable parts.
b. Provide approved engineering submittals.
c. Provide manufacturer's installation wiring diagrams.
d. Include as-installed color-coded wiring diagrams.
e. Operating procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instruction. Include summer, winter, and any special operating instructions.
f. Maintenance requirements: Include routine procedures and guide for troubleshooting; disassembly, repair and reassembly instructions; and alignment, adjusting, balancing and checking instructions.
g. Include manufacturer's printed installation, operation and maintenance instruction.
h. Provide manufacturer's control diagram for each particular item.
i. Include sequence of operation by controls manufacturer.
j. Provide original manufacturer's parts list, illustration, assembly drawings, and diagrams required for maintenance.
k. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

1.3 OWNERSHIP OF PROPRIETARY MATERIAL

A. Government shall retain all rights to software and passwords used for this project.

B. Government will sign copy of manufacturer’s standard software and firmware licensing agreement as condition of this contract. Such license shall grant use of all programs and application software to Government as defined by manufacturer’s license agreement, but shall protect manufacturer’s rights to disclosure of Trade Secrets contained within such software.

C. Licensing agreement shall not preclude use of software by individuals under contract to Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to Government will be restricted to use on Government’s computers, and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation shall become property of Government.

1.4 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

B. Source Limitations: Obtain double-ended switchgear**[and all switchgear specified in [Section 262313 "Paralleling Switchgear,"]]** through one source from single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of double-ended switchgear and are based on specific system indicated. Other manufacturers' products complying with requirements may be considered.

D. Comply with the OBO Electrical Code (NFPA 70 "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

E. Standards: Conform to the following:

1. American National Standards Institute (ANSI):

a. C37.13 Standard for Low-Voltage AC Power Circuit breakers Used in Enclosures
b. C37.16 Switchgear - Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
c. C37.20.1 Metal Enclosed Low-Voltage Power Circuit-Breaker Switchgear
d. C37.50 Test Procedures of Low-Voltage AC Power Circuit Breakers Used in Enclosures
e. C37.51 Conformance Test Procedures of Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies

2. Underwriters Laboratories, Inc. (UL):

a. 1558 Metal Enclosed Low-Voltage Power Circuit Breaker Switchgear

F. Certification: Provide certificate of compliance to referenced standards from manufacturer of switchgear.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver double-ended switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store double-ended switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover double-ended switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear. Install electric heating (250 W per section) to prevent condensation.

1.6 PROJECT CONDITIONS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between all surrounding electrical equipment (clearances based on equipment ratings or manufacturer requirements), and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding **[40][50][60]** deg C.
2. Altitude: Derate as required if over <altitude> above sea level.
3. Relative humidity: Up to 100 percent non-condensing.
4. Seismic Acceleration.

1.7 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses.
2. Indicating Lights: Six of each type installed.
3. Plug in Relays: Three of each type used.

4. Touchup Paint: Three containers of paint matching enclosure finish, each 250 mL

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Siemens Energy & Automation, Inc.
2. GE Electrical Distribution & Control.
3. Square D Co./Groupe Schneider NA.
4. Cutler-Hammer, Inc.

2.2 GENERAL

A. Provide low-voltage metal-enclosed double-ended switchgear consisting of stationary structure on and within which shall be mounted power air circuit breaker units, overcurrent and other protective devices, buses, barriers, and devices designed, manufactured and tested in accordance with NEMA SG 5 and all referenced ANSI standards as minimum requirements.

B. Arrange double-ended switchgear for connection to the Site Distribution Voltage incoming line through bottom of gear.

C. Double-ended switchgear shall be indoor type and furnished in single line-up assembly.

D. Power double-ended switchgear from same source; power both ends from either generator source or from utility source. Switchgear shall not be powered by combination of utility and generator source at the same time. Closed transition is not permitted.

E. Circuit breakers shall be minimum of 800-ampere frame.

F. Breakers/feeders with trip ratings at or under 800 ampere shall be switchboard construction. See Division 26 Section on switchboards.

G. Vertical secondary distribution switchgear sections shall align front and rear with depth.

H. Double-ended switchgear shall be complete factory assembled, wired and tested before delivery to site.

I. Place UL labels on required sections of double-ended switchgear in factory before delivery to site.

J. Double-ended switchgear shall be rated for Site Distribution Voltage, with 100 percent neutral.

K. Control wiring within switchgear shall be minimum of 2.5 mm^2 insulated copper; larger conductor sizes, if required to perform intended function, shall be furnished by equipment manufacturer. Conductor insulation shall be suitable for operating temperature of 90 deg C, and shall be one of types approved and listed by NFPA 70 for use in substation construction. Neatly rack and bind control wiring with self-locking plastic ties. Make termination of control wiring for internal and external connections in numbered strips, complete with permanent wire markers on each wire. Connectors used at terminal locations shall be of pressure lug type.

L. Removable rear access panels shall be of hinged type.

M. Completely enclose front with hinged panels covering each breaker, metering, or blank compartment.

N. Provide hinged covers with hinges, latches, and cut-outs where necessary for ventilation, operating mechanism, mechanical trip, and position indication.

O. Each compartment, such as circuit breaker, metering, current transformer, bus and cable compartments of the total assembly shall be completely and totally isolated on top, bottom, except cable compartments, and sides from all other compartments by suitable metal barriers.

P. Arrange separate steel breaker compartments in tiers in each unit section. Provide barrier to divide each unit section vertically into compartments.

Q. Provide engraved nameplates for main, and feeder circuits, including control fuses and indicating lights and instruments. Nameplates shall give item designation, circuit number, name of load servicing, frame ampere rating, sensor ampere rating, and trip ampere rating. Secure nameplates fastened to equipment with screws. Provide white laminated nameplates with black letters engraved, approximately 50 mm by 75 mm with 6 mm high lettering.

R. Provide master nameplate giving double-ended switchgear designation, voltage, ampere rating, bracing, manufacturer's name, identification, reference and serial numbers.

S. Arrange double-ended switchgear for service as indicated on Drawings complete with spares, spaces and circuit protective devices with capacities indicated.

T. Fabricate structure so that extension of double-ended switchgear may be accomplished in future by addition of new cubicles and by simple splice plates on horizontal bus. Where "space" is indicated on Drawings, space shall be completely bussed and provided with breaker draw-out mechanism for future acceptance of breaker and its instrumentation.

U. Installation and connection of switchgear shall not require removal or disassembly of any factory mounted stationary high voltage devices.

V. Provide 10 percent spare circuit breakers installed in switchgear, 20 percent spaces for future breakers, and 20 percent overall spare current carrying capacity for future expansion.

W. Arc Flash Maintenance Reduction Switch (ARMS): Dual parameter sets that enable trip unit, when activated by maintenance personnel, to automatically lower instantaneous setting, and thereby lower available energy in fault condition (commonly referred to as “maintenance mode”); this causes breaker to trip faster when maintenance is being performed in proximity to energized equipment, thus minimizing arc flash dangers. Refer to Section 260573 “Overcurrent Protective Device Coordination Study” for required arc flash levels or alternative means of compliance for worker safety protection.

2.3 ENCLOSURE

A. Enclosure shall be listed under UL-1558 "Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear." Switchgear assembly shall be UL listed and labeled.

B. Completely isolate each breaker compartment from other breaker compartments by grounded metal barriers.

C. To the extent practicable, fabricate each breaker compartment door without ventilation slots for operator safety. If ventilation slots are required, then they shall be located in such a way prevent possibility of metal objects being inserted through them and easily contacting energized parts.

D. Door of each breaker compartment shall remain closed when racking the breaker to any of its three positions (disconnected, test, connected) unless double steel barrier exists between operating personnel and breaker mechanism/live parts which make it safe to operate breaker with outer steel door open.

E. Each section enclosure shall consist of three compartments: Breaker compartment located in the front, bus compartment located in center, and cable compartment located at rear. Isolate breaker compartment and bus compartment from each other by barriers. Each section of the switchgear shall be provided with a thermostatically controlled space heater.

F. Breaker compartment shall contain drawout circuit breaker elements. Active and spare breaker cells shall be complete with circuit breaker, breaker drawout mechanism and all instrumentation.

G. Bus compartment shall contain section riser and the main cross bus.

H. Size cable compartment to accommodate incoming and outgoing cables, including future cables associated with future breakers required within each vertical switchgear section.

I. Mount integral, roll along breaker lifting device on top of distribution switchgear enclosure.

J. All secondary circuit breakers shall be top or bottom fed.

K. Power for space heaters, work lights and convenience receptacles shall be obtained from a transformer with the switchgear.

2.4 FABRICATION

A. Finish: IEEE C37.20.1 “Metal Enclosed Low-Voltage Power Circuit-Breaker Switchgear,” manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

B. Equip circuit-breaker compartments to house drawout-type circuit breakers, and fit with hinged outer doors.

C. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:

1. Incoming-line pull sections.
2. Hinged front panels for access to metering, accessory, and blank compartments.

2.5 BUS STRUCTURE

A. Provide bus bars between vertical sections and between compartments. Cable connections are not permitted.

1. Main Phase Bus: Fully rated the entire length of assembly; do not taper.
2. Neutral Bus: 100 percent of phase-bus ampacity. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors..
3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
4. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
5. Use copper for connecting circuit-breaker line to copper bus.
6. Contact Surfaces of Buses: Silver plated.
7. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 6 mm by 50 mm. Extend entire length of the switchgear.
9. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
10. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors.
11. Neutral Disconnect Link: Bolted, uninsulated, 6 mm by 50 mm copper bus, arranged to connect neutral bus to ground bus, if required.
12. Facilitate future extensions from either end of main phase, neutral, and ground bus by providing predrilled bolt-holes and connecting links.
13. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape, or vertical and horizontal busses shall be isolated from the cable compartments by glass reinforced polyester barriers.
14. Size busbars to limit temperature rise to 65 deg C above 40 deg C ambient temperature, but shall not exceed 155 amperes per square centimeter.

15. Brace busbars contained in each section to withstand mechanical forces exerted during short circuit conditions. Minimum short circuit bracing shall be 65,000 amperes RMS symmetrical at Site Distribution Voltage.
16. Completely isolate/insulate entire switchgear bus system with insulated nut covers or grounded metal barriers to preclude accidental contact with live busbars while working in outgoing power cable compartment. The only exposed energized parts in rear power cable compartment shall be outgoing feeder connections.
17. A-B-C type bus arrangement, left-to-right, top-to-bottom, and front-to-rear, as viewed from the front, shall be used throughout. Mount main horizontal bus bars with all three phases arranged in same vertical plane. Provide full capacity neutral.
18. Identify busbars in each cubicle, both line and load, with adhesive red letters applied to busbar. This identification shall be in each cubicle, as seen from rear cable compartment for all phases, neutral and ground busses in accordance with A-B-C type bus arrangement defined above.
19. Busbar supports shall be non-carbonizing, non-tracking insulators arranged to provide short circuit bracing of 65,000 amperes symmetrical at Site Distribution Voltage.
20. Provide fire-resistive supports to which cable shall be adequately secured and racked within rear compartment.
21. Segregate buses in separate compartment from breaker and feeder cable compartment.
22. Provide main breaker section with vertical barriers between sections extending all the way to rear.
23. Provide main circuit breaker with horizontal isolation barrier or combination of barriers to completely separate bus line from load bus.
24. Provide black vinyl plastic "mimic bus" on front of switchgear depicting current distribution (flow) through each circuit protective device. Secure bus to switchgear enclosure using screws and nuts.
25. From terminals on load side of breaker compartment, extend insulated bus toward back of board to vertical wiring compartment to avoid cables threaded through line bus bars.

2.6 COMPONENTS

A. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary-voltage rating of Utilization Voltage or Control Voltage, and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.

B. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
2. Switch-selectable digital display of the following:

a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Three-Phase Real Power: Plus or minus 2 percent.
e. Three-Phase Reactive Power: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.

3. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
4. Unit shall have built-in communications capability which allows communication to the Electrical Power Monitoring System. It shall be possible to monitor and trend electrical demand and energy use, as well as other features specified above in switch-selectable digital display, through the Electrical Power Monitoring System.
5. Provide unit at each circuit breaker (mains, ties and feeders).

C. Relays: Comply with IEEE C37.90, types and settings as indicated, with test blocks and plugs.

D. [Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.]

E. Provide controllers or relays required for implementation of applicable sequence scenario in Section 262325 “Power Sequence of Operation.” Relays shall operate on DC control voltage. "Sequence of operation" involves start and stop of multiple generators and open and close of multiple circuit breakers. Provide power system controller for controlling essential bus main breaker, utility bus main breaker, and tie breaker between essential and utility buses. Controller shall use programmable logic controller (PLC); electromagnetic control relays are not permitted. Provide duplicate “hot standby” PLC in same enclosure as primary. Changeover shall require only moving keyed wiring connects and resetting processor. Provide DC power system, including required batteries, charger, cabinet, and other accessories needed to control all electrically operated circuit breakers for implementation of "sequence of operation" as described in this Section. Provide DC power from this system to switchgear as needed to operate all circuit breakers.

F. Upon loss of utility power on incoming side of circuit breaker CB1, circuit breaker CB1 shall trip after adjustable time delay (0-30 seconds); set at 15 seconds and field verify setting. Time delay setting shall be higher than time required for generator to come on line and be ready to accept loads. Loss of voltage sensing is required to comply with the Sequence of Operation as defined in applicable Article in Section 262325 “Power Sequence of Operation.”

G. Upon loss of utility power on incoming side of circuit breaker CB3, circuit breaker CB3 shall trip after adjustable time delay (0-30 seconds); set at 15 seconds and field verify setting. Time delay setting shall be higher than time required for generator to come on line and be ready to accept loads. Loss of voltage sensing is required to comply with applicable Article in Section 262325 “Power Sequence of Operation.”

2.7 CIRCUIT BREAKERS

A. Description: Comply with IEEE C37.13 “Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.”

B. Main, tie and feeder breakers shall be drawout type capable of interrupting available short circuit.

C. Main, tie and feeder breakers shall be rated for 100 percent of their continuous ampere rating.

D. Main, tie and feeder breakers shall be rated for minimum of 65,000 amperes symmetrical.

E. Breakers trip mechanism shall be of solid state trip as specified for main breakers and feeder breakers.

F. Breakers shall be UL listed for application in intended enclosure.

G. Provide breakers with true, stored energy mechanism providing maximum of 6 cycle closing. Energy required for closing breaker shall be completely stored and held in readiness pending release to close action. Mechanism shall be charged by constant force manual charging lever. Breaker shall have multiple charge/close provisions providing the following possible sequence: Charge - close - recharge - open - close - open. As safety feature, provisions shall be available to manually discharge stored energy without closing breaker.

H. Breaker control face plate shall include color coded visual indicators to indicate contact "open" and "closed" positions, and to indicate mechanism "charge" and "discharged" positions. Provide local control pushbuttons for opening the breaker.

I. Provide breakers with self-aligning fingers to engage line and load primary disconnects. Drawout mechanism shall firmly support breaker from fully connected to fully disconnected position.

J. Provide selective override circuit on breakers having short time adjustments that will allow breaker to be applied at its maximum interrupting rating while providing full selectivity up to its rms symmetrical short-time rating. This selective override circuit shall allow breaker to ride through fully offset (asymmetrical) fault equal to its rms symmetrical short-time rating in system having an X/R ratio of 6.6 with maximum single phase peak current of 2.3 times the rms symmetrical short time rating.

K. Locate instrumentation required for each breaker in one place in compartment to eliminate cross-hinge wiring. Instrumentation shall include control fuse blocks, blown fuse lock-out relays, etc., as required for breaker operation.

L. Provide primary disconnect shutter to form protective barrier in front of energized primary disconnects when breaker is moved to its disconnected position.

M. Insulate and support vertical buses provide insulation between adjacent bus bars.

N. Main and Tie Breakers:

1. Breakers shall be electrically operated, sized as shown on the drawings. Control power shall be provided from DC power system.
2. Breakers shall have high endurance characteristics as listed in ANSI Standards. Breakers shall be equipped with field replaceable contacts.
3. Provide complete system selective coordination using single, self-contained programmer having harmonic restraint characteristics with the following nine function solid state trip mechanism:

    a. Current setting.
    b. Long time pickup.
    c. Long time delay.
    d. Short time pickup.
    e. Short time delay (l^2t).
    f. Ground fault pick-up.
    g. Ground fault delay (l^2t).
    h. Fault trip annunciator.

4. Make adjustments of solid state trip mechanism using dial type switches as part of solid state trip mechanism described in complete system selective coordination above.
5. Provide fault trip annunciator with up to three visual indicators to indicate automatic trip point mode of breaker:

    a. Overload.
    b. Short circuit.
    c. Ground fault.

6. Provide ground fault protection as part of solid state trip mechanism.
7. Breakers shall have adjustable trip setting.
8. Provide main breaker with phase failure/phase reverse relay.

O. Feeder Breakers:

1. Breakers shall be 100 percent rated.
2. Breakers shall be manually operated, sized as indicated on Drawings.
3. Equip breakers with nine function solid state trip mechanism with the following adjustments:

    a. Current setting.
    b. Long time pickup.
    c. Long time delay.
    d. Short time pickup.
    e. Short time delay (l^2t).
    f. High range instantaneous pick-up.
    g. Ground fault pick-up.
    h. Ground fault delay (l^2t).
    i. Fault trip annunciator.

4. Make adjustments of solid state trip mechanism using dial type switches as part of solid state trip mechanism described in complete system selective coordination above.
5. Provide fault trip annunciator with up to three visual indicators to indicate automatic tripping mode of breaker:

    a. Overload.
    b. Short circuit.
    c. Ground fault.

6. Provide ground fault protection as part of solid state trip mechanism.
7. Breakers of same frame shall be interchangeable.
8. Breakers 800 amperes frame shall have adjustable trip setting between 100 amperes and 800 amperes.
9. Breakers 1600 amperes frame shall have adjustable trip setting between 300 amperes and 1600 amperes.

P. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, provide quantity indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to terminal block in stationary housing.

Q. Drawout Features: Equip circuit-breaker mounting assembly with racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with associated compartment door closed, unless live parts are covered by full dead-front shield. Open circuit breaker may be manually withdrawn to position for removal from structure with door open. Status for connection devices for different positions includes the following:

    a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
    b. Disconnected Position: Primary and secondary devices and ground contact disengaged.

3. Provide trip/close control switch for circuit breakers in accordance with the Section 262325 “Sequence of Operation.”
4. Provide single “HAND/AUTO” selector switch.
5. When circuit breakers are in the test position, operator shall be able to open and close circuit breakers through their associated trip/close control switch, when position of “HAND/AUTO” selector switch is in “HAND” mode only.
6. When circuit breakers are in connect position, operator shall be able to open and close circuit breakers through their associated trip/close control switch only when operating in “HAND” mode. Operator shall not be able to open or close circuit breakers when operating

in "AUTO" mode. Circuit breakers shall be capable of opening and closing automatically when "HAND/AUTO" selector switch is in "AUTO" mode.

a. [For close operation in the "HAND" mode refer to Article on SEQUENCE OF OPERATION: UTILITY/ATS.]

R. Include provisions for installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

S. Electric Trip/Close Control Switch: One for each electrically operated circuit breaker.

T. Indicating Lights: To indicate circuit breaker is open or closed, for all air circuit breakers (green for open, red for closed).

2.8 DC POWER SYSTEM

A. General:

1. Provide 48 VDC power system for control power required for all switchgear device operations.
2. System shall consist of required number of batteries, battery cabinet, battery charger(s) and other components required for proper operation of this system.

B. Battery Charger:

1. Battery charger shall be voltage-regulated type.
2. Size battery charger with ampere rating sufficient to meet simultaneous demand of required switchgear loads and self-discharge losses of batteries.

C. Cabinet:

1. Mount components in cabinet, with footprint approximately 0.6 m deep by 1.5 m high.
2. Access to the cabinet shall be from front, using hinged doors.

D. Batteries:

1. Battery Type: Batteries shall be of sealed, maintenance free lead acid type.
2. Expected life: 10 year life when operated and maintained within specifications.
3. Nominal Battery String Voltage: 48 VDC
4. Final Discharge Voltage: 42 VDC (1.75 volts per cell).
5. Nominal Float Voltage: 54 VDC (2.25 volts per cell)
6. Battery Recharge Time: Charger shall have capacity to recharge batteries from 10 percent to 90 percent capacity in 12 hours.
7. Battery Circuit Protection: Via fuse or circuit breaker.
8. Nominal Battery Ampere Hour (A.H.) Capacity: **[100][XX]** A.H. **[sized to provide proper operation of the gear for at least 48 hours with the anticipated number of breaker operations likely to occur with [YY] commercial power losses and returns.]**

2.9 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.

1. Racking handle to manually move circuit breaker between connected and disconnected positions.
2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

2.10 IDENTIFICATION

A. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
2. Medium: Painted graphics.
3. Color: Contrasting with factory-finish background.

2.11 FACTORY TESTING

A. Perform factory test of switchgear.

1. Perform each case identified in applicable Articles in Section 262325 “Power Sequence of Operation.”
2. All test results shall be documented including all failed tests.
3. Re-test all failed tests until successful test is achieved.
4. Factory testing may be witnessed by the Government representative. Provide notification to Project Director/COR within 30 calendar days of scheduled test. Government representative may perform factory inspection at that time as well.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchgear for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Mounting of switchgear:

1. Unit shall be bolted directly to housekeeping pad.
2. Concrete Base: Install in accordance with Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section on identification for electrical systems.

B. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.

3.4 CONNECTIONS

A. Install equipment grounding conductors for switchgear with ground continuity to main electrical ground bus.

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: After installing switchgear and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Perform each electrical test and visual and mechanical inspection in accordance with InterNational Electrical Testing Association (NETA) “Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems (ATS).” Certify compliance

with test parameters. Perform NETA ATS tests and inspections for each of the following NETA ATS categories:

a. Switchgear: Perform tests and inspections stated in NETA ATS, Section 7.1.
b. Circuit Breakers: Perform tests and inspections stated in NETA ATS, Section 7.6.
c. Protective Relays: Perform tests and inspections stated in NETA ATS, Section 7.9.
d. Instrument Transformers: Perform tests and inspections stated in NETA ATS, Section 7.10.
e. Metering and Instrumentation: Perform tests and inspections stated in NETA ATS, Section 7.11.
f. Ground-Fault Systems: Perform tests and inspections stated in NETA ATS, Section 7.14.

2. Correct malfunctioning units on-site, where possible, and retest as specified above until compliance is demonstrated,

C. Infrared Scanning: Within 60 days of issuance of Substantial Completion, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner. Testing shall include connections and inductive heating of cabling at entrances or where racked in trenches.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics.

3.7 CLEANING

A. Upon completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.9 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that switchgear is installed and connected according to Contract Documents.

C. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."

1. Train post maintenance personnel on procedures and schedules for general troubleshooting, servicing, and maintaining equipment and schedules, and for equipment isolation and de-energizing procedures.
2. Demonstrate compliance with the requirements of Section 262325 "Sequence of Operation."
3. Refer to Article on ARC FLASH TRAINING in Section 260573 "Overcurrent Protective Device Coordination Study" for associated training requirements.
4. Review data in maintenance manuals.
5. Schedule training with the Project Director/COR with at least seven days' advance notice.

END OF SECTION 262315

SECTION 262325 - POWER SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes metal-enclosed, low-voltage, power circuit-breaker double-ended switchgear rated 1000 V and less for use in ac systems.

B. Related Sections include the following:

1. Section 142105 “Electric Traction Elevators.”
2. Section 230905 “Instrumentation and Controls for HVAC” for building automation system (BAS) for mechanical systems.
3. Section 260508 “Common Work Results for Electrical, Communications and Electronic Safety” for facility voltages and safety accessories.
4. **[Division 26 Section on vibration and seismic controls for electrical systems for mounting and anchoring switchgear.]**
5. Section 260573 “Overcurrent Protective Device Coordination Study” for arc flash study, ARMS reduction level or alternative means of compliance for worker safety, and arc flash training.
6. Section 260915 “Electrical Power Monitoring.”
7. Section 262300 “Low-Voltage Switchgear.”
8. Section 262313 “Paralleling Switchgear.”
9. Section 262315 “Double-Ended Switchgear.”
10. Section 262412 “Switchboards.”
11. Division 26 Section on fuses for fuses and spare-fuse cabinets.
12. Section 263214 “Engine Generators.”
13. Section 263237 “Resistive Load Banks.”
14. Section 263600 “Transfer Switches.”

1.2 SUBMITTALS

A. Operation Data: For sequence indicated, include manufacturers' technical data on features, performance, operation, timing, and control.

B. Shop Drawings: For sequence of operation and controller.

1. Wiring Diagrams: Provide required wiring diagrams to indicate signal, and control wiring. Wiring diagrams shall differentiate between manufacturer-installed and field-installed wiring details. In addition, wiring diagrams shall show all required relays and interface devices needed for proper operation of power distribution system. Refer to other Division 26 Sections for interface requirements with this switchgear.

C. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

E. Qualification data for testing agency as required in Article on QUALITY ASSURANCE.

F. Maintenance Data: For sequence of operation, include maintenance manuals for scenarios indicated and for testing and operation procedures. In addition to requirements specified in Division 01, include the following:

G. Maintenance and Operating Manuals:

1. Contents:

a. Routine testing requirements for sequence of operation and all installed components.
b. Operating procedures: Include start-up, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instruction. Include summer, winter, and any special operating instructions.
c. Include manufacturer's printed operation and maintenance instruction.
d. Provide manufacturer's control diagram for each particular item.

1.3 OWNERSHIP OF PROPRIETARY MATERIAL

A. Government shall retain all rights to software and passwords used for this project.

B. All project developed software, files and documentation shall become property of Government.

1.4 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.5 PROJECT CONDITIONS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between double-ended switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 COORDINATION

A. Coordinate sequence of operation with all installed electrical equipment and components.

B. A pre-transfer contact closure signal (user selectable from 30 to 120 seconds) shall be sent to the elevator controllers to allow the elevators to be parked with doors open prior to switching from standby power to normal power.

1.7 LOSS OF POWER FROM UTILITY COMPANY

A. Definition: It is considered to be a loss of power from utility company not only if the power is interrupted, but also if the power is abnormal (i.e., any of the power parameters are outside the limits for the time periods as specified below).

1. Undervoltage (dropout): < 90 percent for 5 seconds (adjustable at least 1 to 10 seconds).
2. Overvoltage (pickup): > 105 percent for 5 seconds (adjustable 1 to 10 seconds).
3. Under/over frequency: > +/- 3 percent for 5 seconds (adjustable 1 to 10 seconds).
4. Reverse Phase: Instantaneous trip (no intentional delay).
5. Loss of phase: >= 5 seconds (adjustable at least 1 to 10 seconds).

B. Generator startup: After loss of power from utility company, generator start signal(s) shall be given. **[Normal source stays connected for ATS.]**Main circuit breaker trips open at the end of any condition timeout.

1. Generators must be up to 90 percent frequency and voltage before supplying loads.
2. Individual generator shall be powering loads within 10 seconds.
3. Multiple paralleled generators shall be supplying loads as soon as possible within 30 seconds.

1.8 POWER FROM UTILITY COMPANY IS RESTORED

A. Definition: It is considered to be a return of normal power (after being on standby power) when all the conditions below have been met.

1. Undervoltage: > 95 percent for 10 minutes (adjustable 1 to 60 minutes).
2. Overvoltage: < 105 percent for 10 minutes (adjustable 1 to 60 minutes).
3. Under/over frequency: within +/- 1 percent for 10 minutes (adjustable 1 to 60 minutes).
4. Restoration of phase: Proper 3-phase operation has been restored for 10 minutes (adjustable 1 to 60 minutes).

B. Transfer to Normal Power: After timeout of any condition above, the transfer sequence back to Normal Utility source shall be started. Transfer shall have a neutral position (open circuit) time delay of 3 seconds (adjustable 1 to 10 seconds) to allow load-side fields to collapse and minimize system switching surges or out-of-phase transition effects.

C. Cooldown: Generator cooldown period shall be 5 minutes (adjustable 1 to 30 minutes).

PART 2 - PRODUCTS

2.1 SEQUENCE OF OPERATION: UTILITY/ATS

A. The following cases No. 1 through No. 10 shall be implemented when circuit breakers “CB1”, “CB2”, “CB3”, “CB4” and “CBM” are operating in the “AUTO” mode. Circuit breakers “CB1”, “CB2” and “CB3” shall be electrically interlocked as such that tie circuit breaker “CB2” shall close only if circuit breakers “CB1” or “CB3” are open. Refer to one-line diagram for designation of circuit breakers, Generators and transformers.

B. Case No. 1: Normal power is available from utility company.

1. CBM (SWG1 main breaker) is closed.
2. CB1 (essential bus main breaker) shall be in closed position.
3. CB2 (tie breaker between essential and utility buses) shall be in open position.
4. CB3 (utility bus main breaker) shall be in closed position.
5. CB4 (breaker between utility bus No. 1 and HVAC bus) shall be in closed position.

C. The following cases No. 2 through No. 10 shall be implemented Monday through Friday from 6:00am to 8:00pm. It shall be possible to adjust time schedule if required.

D. Case No. 2: In the event of loss of power from utility company, or failure of any of medium voltage feeders or service transformer or automatic voltage regulator, and both E and U are available, the following sequence shall be initiated:

1. CBM shall open.
2. Generator "E" (essential) shall start automatically.
3. Generator "U" (utility) shall start automatically.
4. ATS-E (essential) transfers service to E.
5. ATS-U (utility) transfers service to U.
6. Power service to essential and utility distribution switchgear is restored.
7. Generators E and U shall be ready to accept loads in less than 10 seconds.

E. Case No. 3: When power from utility company is restored or when medium voltage feeder or service transformer or automatic voltage regulator is back in service (Case No. 2), the following sequence shall be initiated:

1. CBM shall close.
2. CB1 shall remain in closed position.
3. CB2 shall remain in open position.
4. CB3 shall remain in closed position.
5. CB4 shall remain in closed position.
6. ATS-E shall transfer service back to utility supply, from Generator E.
7. ATS-U shall transfer service back to utility supply, from Generator U.
8. Generators E and U shall continue to run (cool down) for period of time as specified in Section 263214, “Engine Generators” before shutting down.

F. Case No. 4: In the event of loss of power from utility company, or failure of any of medium voltage feeders or service transformer or automatic voltage regulator, and Generator E is available, but Generator U is not available, the following sequence shall be initiated:

1. CBM shall open.
2. Generator E shall start automatically.
3. ATS-E shall transfer service to E.
4. CB1 shall remain in closed position.
5. CB3 shall open, after specified time delay. (Refer to Article on COMPONENTS).
6. CB4 shall open.
7. CB2 shall close, after both CB3 and CB4 are open.
8. ATS-U will not transfer service to unavailable source.
9. Generator E shall be ready to accept loads in less than 10 seconds.

G. Case No. 5: In the event that Generator U becomes available after implementation of sequence of operation listed under Case No. 4, the following sequence shall be initiated:

1. CBM is open.
2. Generator U shall start automatically.
3. ATS-U shall transfer service to U.
4. CB2 shall open, after detection of voltage on line side of CB3.
5. CB3 shall close, after CB2 is open.
6. CB4 shall close.
7. Generator U shall be ready to accept loads in less than 10 seconds.

H. Case No. 6: When power from utility company is restored or when the medium voltage feeder or service transformer or automatic voltage regulator is back in service (Case No. 4), the following sequence shall be initiated:

1. After specified time delay, CBM shall close.
2. CB1 shall remain in closed position.
3. ATS-U shall transfer service back to utility supply, from Generator U, if required.
4. ATS-E shall transfer service back to utility supply, from Generator E.
5. CB2 shall open, after detection of voltage on line side of CB3.
6. CB3 shall close, after CB2 is open.
7. CB4 shall close.
8. Generators E shall continue to run (cool down) for period of time as specified in Section 263214 ”Engine Generators” before shutting down.

I. Case No. 7: In the event of loss of power from utility company, or failure of any of medium voltage feeders or service transformer or automatic voltage regulator, and Generator E is not available, but Generator U is available, the following sequence shall be initiated:

1. CBM shall open.
2. Generator U shall start automatically.
3. ATS-U shall transfer service to Generator U.
4. CB3 shall remain in closed position.
5. CB1 shall open, after specified time delay.

6. CB4 shall open.
7. CB2 shall close, after both CB1 and CB4 are open.
8. ATS-E will not transfer service to unavailable source.
9. Generator U shall be ready to accept loads in less than 10 seconds.

J. Case No. 8: In the event that Generator E becomes available after implementation of sequence of operation listed under Case No. 7, the following sequence shall be initiated:

1. CBM is open.
2. Generator E shall start automatically.
3. ATS-E shall transfer service to E.
4. CB2 shall open, after detection of voltage on line side of CB1.
5. CB1 shall close, after CB2 is open.
6. CB4 shall close.
7. Generator E shall be ready to accept loads in less than 10 seconds.

K. Case No. 9: When power from utility company is restored or when medium voltage feeder or service transformer or automatic voltage regulator is back in service (Case No. 7), the following sequence shall be initiated:

1. CBM shall close.
2. CB3 shall remain in closed position.
3. ATS-E shall transfer service back to utility supply, from Generator E, if required.
4. ATS-U shall transfer service back to utility supply, from Generator U.
5. CB2 shall open, after detection of voltage on line side of CB1.
6. CB1 shall close, after CB2 is open.
7. CB4 shall close.
8. Generators U shall continue to run (cool down) for period of time as specified in this Section before shutting down.

L. Case No. 10: When power from utility company is restored or when medium voltage feeder or service transformer or automatic voltage regulator is back in service (Case No. 5 and No. 8), the following sequence shall be initiated:

1. After specified time delay, CBM shall close.
2. CB1 shall remain in closed position.
3. CB2 shall remain in open position.
4. CB3 shall remain in closed position.
5. CB4 shall remain in closed position.
6. ATS-E shall transfer service back to utility supply, from Generator E.
7. ATS-U shall transfer service back to utility supply, from Generator U.
8. Generators E and U shall continue to run (cool down) for period of time as specified in Section 263214 ”Engine Generators” before shutting down.

M. The following Cases No. 11 through No. 15 shall be implemented Monday through Friday from 8:00pm to 6:00am and Saturday and Sunday. It shall be possible to adjust time schedule if required.

N. Case No. 11: In the event of loss of power from utility company, or failure of any of medium voltage feeders or service transformer or automatic voltage regulator, and both Generators E and U are available, the following sequence shall be initiated:

1. CBM shall open.
2. CB1 shall remain in closed position.
3. Generator E (essential) shall start automatically.
4. ATS-E (essential) shall transfer service to Generator E.
5. CB3 shall open, after specified time delay. (Refer to Article on COMPONENTS).
6. CB2 shall close, after CB3 is open.
7. The loads connected to Generator E shall be continuously monitored. It shall be possible, if required, for operator to manually connect load bank to Generator with required load steps needed to ensure that Generator is at least loaded to 50 percent of its rating.
8. ATS-U (utility) shall not transfer service to Generator U.
9. Power service to essential and utility distribution switchgear is restored.
10. Generator "E" shall be ready to accept loads in less than 10 seconds.

O. Case No. 12: When power from utility company is restored or when medium voltage feeder or service transformer or automatic voltage regulator is back in service (Case No. 11), the following sequence shall be initiated:

1. After specified time delay, CBM shall close.
2. CB1 shall remain in closed position.
3. CB2 shall open, after detection of voltage on line side of CB3.
4. CB3 shall close, after CB2 is open.
5. CB4 shall remain in closed position.
6. ATS-E shall transfer service back to utility supply, from Generator E.
7. Power service to essential and utility distribution switchgear is restored.
8. Load bank, if connected, shall be disconnected.
9. Generator E shall continue to run (cool down) for period of time as specified in Section 263214 “Engine Generators” before shutting down.

P. Case No. 13: In the event of loss of power from utility company, or failure of any of medium voltage feeders or service transformer or automatic voltage regulator, and Generator E is not available, but Generator U is available, the following sequence shall be initiated:

1. CBM shall open.
2. CB3 shall remain in closed position.
3. Generator U shall start automatically.
4. ATS-U (utility) shall transfer service to Generator U.
5. CB1 shall open, after specified time delay; refer to Article on COMPONENTS.
6. CB4 shall remain in closed position.
7. CB2 shall close, after CB1 is open.
8. The loads connected to Generator U shall be continuously monitored. It shall be possible, if required, for operator to manually connect load bank to Generator with required load steps needed to ensure that Generator is at least loaded to 50 percent of its rating.
9. ATS-E shall not transfer service to E.
10. Power service to essential and utility distribution switchgear is restored.

11. Generator U shall be ready to accept loads in less than 10 seconds.

Q. Case No. 14: In the event that Generator E becomes available after implementation of sequence of operation listed under Case No. 13, no changes to sequence of operation shall be made.

R. Case No. 15: When power from utility company is restored or when medium voltage feeder or service transformer or automatic voltage regulator is back in service (Case No. 13), the following sequence shall be initiated:

1. CBM shall close.
2. CB3 shall remain in closed position.
3. CB2 shall open, after detection of voltage on line side of CB1.
4. CB1 shall close, after CB2 is open.
5. CB4 shall remain in closed position.
6. ATS-U shall transfer service back to utility supply, from Generator U.
7. Power service to essential and utility distribution switchgear is restored.
8. Generator U shall continue to run (cool down) for period of time as specified in Section 263214 “Engine Generators” before shutting down.

S. The following cases No. 16 through No. 26 shall be implemented when circuit breakers CB1 or CB2 or CB3 are not operating under “AUTO” mode and as such ‘HAND” mode will have to be implemented, and during Monday through Friday from 6:00am to 8:00pm. It shall be possible to adjust time schedule if required. Circuit breakers CB1, CB2 and CB3 shall be electrically interlocked as such that tie circuit breaker CB2 shall close only if circuit breakers CB1 or CB3 are open.

T. Case No. 16: When utility or Generator power is available at line side of circuit breakers CB1 and CB3, but two breakers not being able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Trip open CB2 through trip/close control switch, if it is closed.
3. Close circuit breakers CB1 and CB3 through trip/close control switch.
4. CB4 shall remain closed.

U. Case No. 17: When utility power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB1 is not being able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. CB2 shall remain in open position.
3. CB4 shall remain in closed position.
4. Close CB1 through trip/close control switch.
5. Close CB3 through trip/close control switch.

V. Case No. 18: When utility power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB1 is not able to close due to malfunction in circuit breaker and "AUTO"

functions are not operational due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to "HAND" mode.
2. Close CB3 through trip/close control switch.
3. Trip open CB4 through trip/close control switch.
4. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
5. Close CB4 through trip/close control switch.

W. Case No. 19: When utility power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB3 is not being able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. CB2 shall remain in open position.
3. CB4 shall remain in closed position.
4. Close CB1 through trip/close control switch.
5. Close CB3 through trip/close control switch.

X. Case No. 20: When utility power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB3 is not able to close due to malfunction in circuit breaker and "AUTO" functions are not operational due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to "HAND" mode.
2. Close CB1 through trip/close control switch.
3. Trip open CB4 through trip/close control switch.
4. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
5. Close CB4 through trip/close control switch.

Y. Case No. 21: When Generator power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB1 is not able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated.

1. Switch the selector switch to “HAND” mode.
2. CB2 shall remain in open position.
3. CB4 shall remain in closed position.
4. Close CB1 through trip/close control switch.
5. Close CB3 through trip/close control switch.

Z. Case No. 22: When Generator power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB1 is not able to close due to malfunction in circuit breaker and "AUTO" functions are not operational due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to "HAND" mode.
2. Close CB3 through trip/close control switch.
3. Trip open CB4 through trip/close control switch.

4. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
5. CB4 shall remain open.

AA. Case No. 23: When there is no power at line side of circuit breaker CB1 due to utility power not being available, E fails to start and power transfer scheme fails to be activated in “AUTO” mode, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Trip open CB1 through trip/close control switch if it is closed.
3. Close CB3 through trip/close control switch.
4. Trip open CB4 through trip/close control switch.
5. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
6. CB4 shall remain open.

BB. Case No. 24: When Generator power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB3 is not able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. CB2 shall remain in open position.
3. CB4 shall remain in close position.
4. Close CB1 through trip/close control switch.
5. Close CB3 through trip/close control switch.

CC. Case No. 25: When Generator power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB3 is not able to close due to malfunction in circuit breaker and "AUTO" functions are not operational due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to "HAND" mode.
2. Close CB1 through trip/close control switch.
3. Trip open CB4 through trip/close control switch.
4. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
5. CB4 shall remain open.

DD. Case No. 26: When there is no power on line side of circuit breaker CB3 due to utility power not being available, U fails to start and power transfer scheme fails to be activated in “AUTO” mode, the following sequence shall be initiated:

1. Switch the selector switch to "HAND" mode.
2. Trip open CB3 through trip/close control switch if it is closed.
3. Close CB1 through trip/close control switch.
4. Trip open CB4 through trip/close control switch.
5. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
6. CB4 shall remain open.

EE. The following cases No. 27 through 38 shall be implemented when circuit breakers CB1 or CB2 or CB3 are not operating under “AUTO” mode and as such ‘HAND” mode will have to be

implemented, and during Monday through Friday from 8:00pm to 6:00am and on Saturday and Sunday. It shall be possible to adjust time schedule if required. Circuit breakers “CB1”, “CB2” and “CB3” shall be electrically interlocked as such that tie circuit breaker “CB2” shall close only if circuit breakers “CB1” or “CB3” are open.

FF. Case No. 27: When utility power is available at line side of circuit breakers CB1 and CB3 but two breakers are not able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Trip open CB2 through trip/close control switch, if it is closed.
3. Close breakers CB1 and CB3 using trip/close control switch.
4. CB4 shall remain closed.

GG. Case No. 28: When utility power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB1 is not being able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Trip open CB2 through trip/close control switch, if it is closed.
3. CB4 shall remain in closed position.
4. Close CB1 using trip/close control switch.
5. Close CB3 using trip/close control switch.

HH. Case No. 29: When utility power is available at line side of circuit breakers CB1 and CB3, but circuit breaker CB1 is not able to close due to malfunction in circuit breaker and “AUTO” functions are not operational due to malfunction in automatic control scheme.

1. Switch the selector switch to “HAND” mode.
2. Close CB3 through trip/close control switch.
3. Trip open CB4 through trip/close control switch.
4. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
5. Close CB4 through trip/close control switch.

II. Case No. 30: When utility power is available at line side of circuit breakers CB1 and CB3 but circuit breaker CB3 is not able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Trip open CB2 through trip/close control switch, if it is closed.
3. CB4 shall remain in closed position.
4. Close CB1 through trip/close control switch.
5. Close CB3 through trip/close control switch.

JJ. Case No. 31: When utility power is available at line side of circuit breakers CB1 and CB3 but circuit breaker CB3 is not able to close due to malfunction in circuit breaker and “AUTO” functions are not operational due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Close CB1 through trip/close control switch.
3. Trip open CB4 through trip/close control switch.
4. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
5. Close CB4 through trip/close control switch.

KK. Case No. 32: When Generator power (E) is available at line side of circuit breaker CB1, but circuit breaker CB1 is not able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Close CB1 through trip/close control switch.
3. Trip open CB3 through trip/close control switch.
4. Close CB2 through trip/close control switch.
5. Close CB4 through trip/close control switch.

LL. Case No. 33: When Generator power is available at line side of circuit breaker CB1, but circuit breaker CB1 is not able to close due to malfunction in circuit breaker and "AUTO" functions are not operational due to malfunction in automatic control scheme.

1. Switch the selector switch to "HAND" mode.
2. Trip open CB1 through trip/close control switch.
3. Close CB3 through trip/close control switch.
4. Trip open CB4 through trip/close control switch.
5. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
6. Close CB4 through trip/close control switch.

MM. Case No. 34: When there is no power at line side of circuit breaker CB1 due to utility power not being available, E fails to start and power transfer scheme fails to be activated in “AUTO” mode, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Trip open CB1 through trip/close control switch if it is closed.
3. Close CB3 through trip/close control switch.
4. Trip open CB4 through trip/close control switch.
5. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
6. Close CB4 through trip/close control switch.

NN. Case No. 35: When Generator power (U) is available at line side of circuit breaker CB3, but circuit breaker CB3 is not able to close under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to “HAND” mode.
2. Close CB3 through trip/close control switch.
3. Trip open CB1 through trip/close control switch.
4. Close CB2 through trip/close control switch.
5. Close CB4 through trip/close control switch.

OO. Case No. 36: When Generator power is available at line side of circuit breaker CB3, but circuit breaker CB3 is not able to close due to malfunction in circuit breaker and "AUTO" functions are not operational due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch the selector switch to "HAND" mode.
2. Trip open CB3 through trip/close control switch.
3. Close CB1 through trip/close control switch.
4. Trip open CB4 through trip/close control switch.
5. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
6. Close CB4 through trip/close control switch.

PP. Case No. 37: When there is no power at line side of circuit breaker CB3 due to utility power not being available, U fails to start and power transfer scheme fails to be activated in “AUTO” mode, the following sequence shall be initiated:

1. Switch the selector switch to "HAND" mode.
2. Trip open CB3 through trip/close control switch if it is closed.
3. Close CB1 through trip/close control switch.
4. Trip open CB4 through trip/close control switch.
5. Close CB2 through trip/close control switch. CB2 cannot close unless CB4 is open.
6. Close CB4 through trip/close control switch.

QQ. Case No. 38: When Generator power (E) is available at line side of circuit breaker CB1 but circuit breaker CB3 is not able to open under “AUTO” mode due to malfunction in automatic control scheme, the following sequence shall be initiated:

1. Switch to "HAND" mode.
2. Close CB1 through trip/close control switch if it is open.
3. Trip open CB3 through trip/close control switch.
4. Trip open CB4 through trip/close control switch.
5. Close CB2 through trip/close control switch.
6. Close CB4 through trip/close control switch.

2.2 SEQUENCE OF OPERATION: UTILITY/PARALLELING SWITCHGEAR

A. The following Cases No. 1 through No. 8 shall be implemented when circuit breakers PSGU, PSGE, PSG1, PSG2, CB1, CB2, CB3 and load shed breaker(s) **[CB4]** are operating in “AUTO” mode. Circuit breakers CB1, CB2 and CB3 shall be electrically interlocked as such that tie circuit breaker CB2 shall close only if circuit breakers CB1 or CB3 are open. Transfer switching pair breakers PSGE/PSG1 and PSGU/PSG2 shall be both electrically and mechanically interlocked. Refer to one-line diagram for designation of circuit breakers, Generators and transformers.

B. Case No. 1: Normal power is available from utility company.

1. PSGU (Generator switchgear incoming breaker 1) shall be in closed position.
2. PSGE (Generator switchgear incoming breaker 2) shall be in closed position.
3. PSG1 (Generator switchgear output breaker 1) shall be in open position.

4. PSG2 (Generator switchgear output breaker 2) shall be in open position.
5. CB1 (essential bus main breaker) shall be in closed position.
6. CB2 (tie breaker between essential and utility buses) shall be in open position.
7. CB3 (utility bus main breaker) shall be in closed position.
8. Load shed breaker(s) **[CB4 (breaker between utility bus No. 1 and HVAC bus)] [name other breakers here and in cases below]** shall be in closed position.

C. Case No. 2: In the event of loss of power from utility company, or failure of any of medium voltage feeders, service transformer or both main incoming circuit breakers or automatic voltage regulator, and N **[=X]** Generators are available, the following sequence shall be initiated:

1. After an adjustable time delay (preset to 5 seconds), PSGE and PSGU shall open.
2. All generators shall start automatically and synchronize as described in Section 263213 "Paralleling Switchgear." Generators shall be ready to accept loads in less than 30 seconds.
3. PSG1 shall close and transfer service to E bus.
4. PSG2 shall close and transfer service to U bus.
5. Power service to essential and utility distribution switchgear is restored.

D. Case No. 3: When power from utility company is restored or when medium voltage feeder or service transformer or main incoming breakers or automatic voltage regulator is back in service (Case No. 2), the following sequence shall be initiated:

1. After an adjustable time delay (preset to 10 minutes), PSG1 shall open.
2. After short delay, PSGE shall close and transfer service to E bus.
3. PSG2 shall open.
4. After short delay PSGU shall close and transfer service to U bus.
5. CB1 shall remain in closed position.
6. CB2 shall remain in open position.
7. CB3 shall remain in closed position.
8. **[CB4]** shall remain in closed position.
9. Generators shall continue to run (cool down) for a period of time as specified in Section 263214 "Engine Generators" before shutting down.

E. Case No. 4: In the event of loss of power from utility company, or failure of any of medium voltage feeders, service transformer, or both main incoming circuit breakers or automatic voltage regulator, (Case 2) and N-1 **[=Y]** Generators are available, the following sequence shall be initiated:

1. PSGE and PSGU shall open.
2. All generators (available) shall start automatically and synchronize as described in Section 263213 "Paralleling Low-Voltage Switchgear". Generators shall be ready to accept loads in less than 30 seconds.
3. Load shed **[breaker CB4 shall open] [priority sequence shall be initiated to match generator availability.]**
4. PSG1 shall close and transfer service to E bus.
5. PSG2 shall close and transfer service to U bus.
6. Power service to essential and utility distribution switchgear is restored. HVAC bus is shed to accommodate lack of Generator availability.

F. Case No. 5: In the event that additional Generator becomes available after implementation of sequence of operation listed under Case No. 4, the following sequence shall be initiated:

1. [CB4 shall close.] [Restore shed loads in priority order.]

G. Case No. 6: When power from utility company is restored or when medium voltage feeder or service transformer or main incoming breakers or automatic voltage regulator is back in service (Case No. 4 or 5), the following sequence shall be initiated:

1. CB1 shall remain in closed position.
2. CB2 shall remain in open position.
3. CB3 shall remain in closed position.
4. **[CB4]** shall remain in closed position.
5. After an adjustable time delay (preset to 10 minutes), PSG1 shall open.
6. After short delay, PSGE shall close and transfer service to E bus.
7. PSG2 shall open
8. After short delay, PSGU shall close and transfer service to U bus
9. Generators shall continue to run (cool down) for a period of time as specified in Section 263214 “Engine Generators” before shutting down.

H. Case No. 7: In the event of loss of breaker PSGE or PSG1, or associated feeder from paralleling switchgear to utility switchgear. Utility power available:

1. PSGE shall open.
2. CB1 shall open.

3. [CB4 shall open.]
4. PSGU shall remain closed.
5. CB2 shall close and transfer service to U bus.
6. Power service to essential and utility distribution switchgear is restored. **[HVAC bus is shed to accommodate lack of additional utility availability.]**
7. After failed element is repaired, the system shall be manually operated to return to Case 1 (normal state).

I. Case No. 8: In the event of loss of breaker PSGU or PSG2, or associated feeder from paralleling switchgear to utility switchgear. Utility power available:

1. PSGU shall open.
2. CB3 shall open.

3. [CB4 shall open.]
4. PSGE shall remain closed.
5. CB2 shall close and transfer service to E bus.
6. Power service to essential and utility distribution switchgear is restored. **[HVAC bus is shed to accommodate lack of additional utility availability.]**
7. After failed element is repaired, the system shall be manually operated to return to Case 1 (normal state).

2.3 [SEQUENCE OF OPERATION: PRIME/PARALLELING SWITCHGEAR]

A. The following cases No. 1 through No. **[X]** shall be implemented when **[xxx xxx.]** Refer to one-line diagram for designation of circuit breakers, Generators, and transformers.

B. Case No. 1: **[Xxx xxx.]**

1. [YYY (xxx xxx) shall …]
2. [ZZZ (xxx xxx) shall …]

2.4 SEQUENCE OF OPERATION: NOB

A. The following shall be implemented when circuit breakers CBA, CBB, and CBC are operating in "AUTO" mode. Circuit breakers CBA, CBB, and CBC shall be electrically interlocked as such that tie circuit breaker CBB shall close only if circuit breakers CBA or CBC are open due to loss of voltage at input of circuit breaker or if breaker has been manually opened and tagged out. Tie breaker CBB shall not close when circuit breaker CBA or CBC are open due to operation of protection circuits for conditions such as overcurrent, overvoltage, or short circuit, etc. Refer to one-line diagram for designation of circuit breakers, Generators and transformers.

B. Case No. 1: Normal power is available from the dual feeds to NOB switchgear.

1. CBA (essential bus main breaker) shall be in closed position.
2. CBB (tie breaker between essential and utility buses) shall be in open position.
3. CBC (utility bus main breaker) shall be in closed position.

C. Case No.2: When voltage is not sensed from single feed to either NOB switchgear main circuit breaker CBA or CBC.

1. After adjustable 0-30 second time delay, Circuit breaker with feeder failure shall open,
2. Circuit breaker operating with voltage detected shall remain closed.
3. Bus tie breaker (CBB) shall close.

D. Case No. 3: Power is restored to feeder in Case No. 2 above:

1. Bus tie breaker CBB shall open.
2. After adjustable 0-30 second time delay, either CBA and CBC (which was opened in Case 2) shall close returning service to both E and U busses of NOB switchgear.

2.5 FACTORY TESTING

A. Perform factory test of switchgear.

1. Perform each case identified in Articles on SEQUENCE OF OPERATION in this Section.
2. All test results shall be documented including all failed tests.
3. Re-test all failed tests until successful test is achieved.

4. Factory testing may be witnessed by the Government representative. Provide notification to Project Director/COR within 30 calendar days of scheduled test. Government representative may perform factory inspection at that time as well.

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Operating Instructions: Printed basic instructions for sequence of operation, including sequences and emergency procedures.

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test all scenarios of sequence of operation.

B. Testing: After installing all switchgear and electrical components, and after electrical circuitry has been energized, demonstrate control capability and compliance with requirements.

1. Perform each electrical test to demonstrate automatic control of all circuit breakers for each scenario identified in sequence of operation.
2. Correct non-compliant sequences.

3.3 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government maintenance personnel to operate and test sequence of operation scenarios. Refer to Division 01 Section “Demonstration and Training.”

1. Train post maintenance personnel on procedures and schedules for general testing procedures.
2. Schedule training with the Project Director/COR with at least seven days' advance notice.

END OF SECTION 262325

SECTION 262412 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V and less.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety” for safety accessories.

2. [See Division 26 Section on “Vibration and Seismic Controls for Electrical Systems.”]
3. Section 260573 “Overcurrent Protective Device Coordination Study.”
4. Section 262325 “Power Sequence of Operation.”
5. See Division 26 Section on "Fuses" or fusible devices in switchboards.
6. Section 264315 “Surge Protective Devices.”

1.2 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of switchboards and overcurrent protective devices.

d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
e. Utility company's metering provisions with indication of approval by utility company.
f. Mimic-bus diagram.
g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Certificates of Compliance: Manufacturer of switchgear shall certify compliance with referenced standards.

E. Qualification data for firms and persons as required in Article on QUALITY ASSURANCE.

1. Testing agency.

F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. Include:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.3 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

D. Standards: In addition to standards identified elsewhere in this Section, conform to the following:

1. Institute of Electrical and Electronics Engineers (ANSI/IEEE):
2. National Electrical Manufacturers Association (NEMA):

a. PB2 Deadfront Distribution Switchboards

E. Underwriters Laboratories, Inc. (UL):

a. 891 “Switchboards”
b. 489 “Molded Case Circuit Breakers

PART 2 - PRODUCT

2.1 MANUFACTURED UNITS

A. Switchboard Construction: Use switchboards with molded case breakers except where coordination and protective relaying require the use of power circuit breakers.

1. Switchboards shall consist of all distribution devices sized at or below 800 amperes trip rating. All other distribution lineups over 800 ampere shall be switchgear construction.

a. Contractor may provide circuit breaker for disconnect and bus ampere reduction from switchgear to switchboard transition.

2. Mechanical/HVAC Bus: Utilize switchboard construction with branch breakers up to 1200 amp rating for distribution to mechanical equipment. Any main or feeder breakers with 1000 amp or greater trip rating shall be drawout type.

B. Switchboard Configuration: Front, side, and rear accessible, with drawout type, individually mounted main device, panel mounted branches, and adjacent vertical sections front aligned.

C. Buses and Bus Connections: Three phase, four wire, unless otherwise indicated. Materials and Features as follows:

1. Main-Bus Continuous Rating: **[[2000] [xx] A.] [as indicated on Drawings.]**
2. Material for Main Bus: Hard-drawn copper of 98 percent conductivity.
3. Connections to Main and Feeder Protective Devices:

a. Copper.

D. Enclosure Finish: Factory-applied finish in manufacturer's standard gray color over a rust-inhibiting primer on treated metal surface.

E. Vertical Barriers: Between adjacent switchboard sections to separate breakers of 800 amp or larger frame sizes.

F. Utility Metering Compartment: Comply with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.

G. Bus Transition and Incoming Pull Sections: Match and align with basic switchboard.

H. Pull Box on Top of Switchboard: Provide adequate ventilation to maintain temperature in pull box within same limits as switchboard.

1. Bottom: Insulating, fire-resistive material with separate holes for cable drops.

I. Cable Supports: Arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

J. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors.

K. Ground Bus: 6-by-50-mm (1/4-by-2-inch) minimum size, drawn-temper copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

L. Contact Surfaces of Buses: Silver plated.

M. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

N. Neutral Buses: 100 percent of the ampacity of the phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.

O. Future Devices: Equip positions with mounting brackets, supports, bus connections, load terminals, and appurtenances rated at maximum capacity available for future unit.

P. [Bus-Bar Insulation: Flame-retardant, 105 deg C minimum tape wrapping, or flame-retardant, sprayed-on insulation of same temperature rating, factory-applied to individual bus bars.]

Q. Provide 10 percent spare circuit breakers, 20 percent spaces for future breakers, and 20 percent overall spare current carrying capacity for future expansion.

R. Provide maintenance mode arc flash reduction switch as applicable to provide dual parameter sets that enable trip unit to automatically lower instantaneous setting, and thereby lower available energy in fault condition (commonly referred to as “maintenance mode”), making breaker trip faster while engaged in any form of maintenance while being in proximity to energized equipment to minimize arc flash dangers. Refer to Section 260573 “Overcurrent Protective Device Coordination Study” for required arc flash levels or alternative means of compliance for worker safety protection.

2.2 SURGE SUPPRESSION DEVICES

A. Provide Surge Suppression in accordance with Section 264315 “Surge Protective Devices.”

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breakers: UL 489, with standard frame sizes, trip ratings, and number of poles, and interrupting capacity to meet available fault currents. Types shall be as indicated on the Drawings.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
2. Ground-Fault Protection: Remote-mounted sensor, relay, and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
3. Shunt Trip: 240 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
5. Auxiliary Switch: One SPDT switch or two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts as noted only.
6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
7. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

C. Enclosed, Insulated-Case Circuit Breaker: Fixed mounting, manually closed, fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

1. Two-step, stored-energy closing.

2. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments with I2t response.
   d. Ground-fault pickup level, time delay, and I2t response.

3. Remote trip indication and control capability.
4. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
5. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Megawatts: Plus or minus 2 percent.
   e. Megavars: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
   i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Watt-Hour Meters: Flush or semiflush type, rated 5 A, 220 or 240 V, 3 phase, 3 wire, with 3 elements, 15-minute-indicating-demand register, and provision for testing and adding pulse initiation.

D. Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semiflush mounting.

2.5 CONTROL POWER

A. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

B. Control Circuits: 220 or 240 V, supplied through secondary disconnecting devices from control-power transformer.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 10 mm^2 and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: To test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Support switchboards on concrete bases, 100-mm nominal thickness.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section on "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Infrared Scanning: Within 60 days of issuance of Substantial Completion, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switchboards checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Report test results in writing.

3.4 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges **[as indicated][as specified in Section XXXXX].**

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Post's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 262412

SECTION 262417 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panelboards.
2. Distribution panelboards.
3. Surge protective device panelboards.
4. Food Service panelboards

B. Related Sections include the following:

1. Section 114000 “Foodservice Equipment.”

2. [Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."]
3. Section 260573 “Overcurrent Protective Device Study.”
4. Section 260915 "Electrical Power Monitoring."
5. Section 264315 “Surge Protective Devices.”
6. Section 280508 "Common Work Results for Technical Security Systems (TSS)” for TSS panelboards.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. MCB: Main circuit breaker.

C. MLO: Main lug only.

D. SPD: Surge protective device.

1.3 SUBMITTALS

A. Product Data - General: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
e. Significant interaction with TSS components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. [Qualification Data: For testing agency.]

D. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. [Independent Testing Agency Qualifications: Where required elsewhere in the Contract, utilize testing agency that is a member company of the InterNational Electrical Testing Association (NETA) and that is acceptable to Project Director/COR based upon input of OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in Part 3.]

B. Comply with NEMA PB 1.

C. Comply with requirements of the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

1.5 PROJECT CONDITIONS

A. [Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 40 deg C (104 deg F).
2. Altitude: Not exceeding 2000 m (6600 feet).]

B. [Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 2000 m (6600 feet).]

C. [Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Post or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Project Director/COR no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Project Director/COR's written permission.]

1.6 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.7 EXTRA MATERIALS

A. Keys: Six spares of each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 FABRICATION AND FEATURES

A. Enclosures: Flush or surface-mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

1. Indoor Locations not Subject to Moisture: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

5. Locations in Marine Environments: **[XX]**.

6. Separate neutral and grounding buses for all panelboards.
7. [Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.]

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Gasketed cover where identified by location.

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door. Complete and install upon completion of load balancing.

F. Panelboards shall have factory ground neutral connection (links, bonds, screws) removed. Only standalone panelboards may have connections per NFPA 70 (NEC) for service locations. All bonding for office compounds shall be bonded at service transformer and main switchgear (paralleling generators or ATS).

G. Bus: Hard-drawn copper.

H. Bus Bars of Power Distribution and Branch Circuit Panelboards:

1. Provide hard drawn copper. The neutral bus shall be isolated from both the ground bus and the cabinet.
2. Mounting shall comply with available interrupting current (AIC) as calculated by arc fault study to minimize arc flash hazards; see Section 260573 “Overcurrent Protective Device Coordination Study.”

I. Main and Neutral Lugs: Compression or mechanical type suitable for use with conductor material.

J. Isolated Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

K. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

L. Surge Protective Device (SPD) Protection: Power and distribution panelboards shall have SPD protection. This protection may be integrated into panelboards. See Section 264315 “Surge Protective Devices.”

M. Spares and Future Device Capacity: Provide mounting brackets, bus connections, and associated appurtenances to support future installation of devices.

1. 20 percent overall spare current carrying capacity for future expansion.
2. Sufficient buss sections with 20 percent spaces for future breakers.
3. 10 percent spare circuit breakers to include at least one spare breaker of each size and rating used in that panelboard.

4. Engineer of Record shall ensure Panelboard schedules do not conflict with any spare or space requirements identified in contract requirements.

N. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

O. Gutter Space: Provide extra wire gutter space needed for all of individual circuit neutral and ground wires.

P. [Split Bus: Vertical buses divided into individual vertical sections.]

Q. [Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.]

R. [Gutter Barrier: Arrange to isolate individual panel sections.]

S. Feed-through Lugs: Compression or mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.2 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 LOAD CENTERS

A. Overcurrent Protective Devices: Plug-in, full-module circuit breaker.

B. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Circuit Panelboards: Branch protective devices in panelboards shall be of the bolt-on type circuit breakers. Locate panelboards at the utility area nearest the center of the load. Panelboards shall have main circuit breakers. Where multiple section panelboards are required, each section shall have a main breaker. Size panels as noted above.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

C. Doors: Front mounted; concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISTRIBUTION PANELBOARDS

A. Power Distribution Panelboards: Panelboards serving three-phase motors and other power equipment shall be of bolt-on circuit breaker type. Size the panel bus, lugs, and circuit breakers to match the transformer kVA and system fault level.

B. Doors: Front mounted; secured with vault-type latch with tumbler lock; keyed alike.

C. Main Overcurrent Protective Devices: Main circuit breaker; do not use Main Lug Only.

2.6 FOODSERVICE PANELBOARDS

A. Electrical Sub-Panel: NEMA 4X stainless steel construction

B. Doors: Front mounted; concealed hinges; secured with flush latch with tumbler lock; keyed alike, fully gasketed.

C. Main Overcurrent Protective Devices: Main circuit breaker; do not use Main Lug Only.

2.7 SURGE SUPPRESSION

A. Transient voltage disturbances from commercial power systems associated with lightning storms and switching surges externally, as well as harmonics generated by adjustable speed drives and SCR power supplies associated with UPS equipment internally may cause stress and damage to electrical equipment. Therefore, surge protection is required at the service entrance to all buildings, at all main distribution panels and all secondary power panels. The surge protection shall be provided in accordance with Section 264315 " Surge Protective Devices."

2.8 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with trip sensitivity in accordance with NFPA (125 V) or IEC (240 V).

B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical or Compression style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application.
3. Ground-Fault Protection: Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Communication Capability: Circuit-breaker-mounted, Universal-mounted, Integral or Din-rail-mounted communication module with functions and features compatible with power monitoring and control system.
5. Shunt Trip: 220 or 240 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.9 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Fungus Proofing: In humid environments, provide permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."

C. Mounting Heights: Top of trim 1880 mm above finished floor, unless otherwise indicated.

D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install high visibility safety striping in front of panelboard areas.

F. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

G. Install filler plates in unused spaces.

H. Provision for Future Circuits at Flush Panelboards: Except in locations where ceilings are not readily accessible, install stub four empty 21-mm metallic rigid conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four empty 21-mm metallic rigid conduits into raised floor space as applicable.

I. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

J. Panelboards mounted on damp or wet surfaces shall be PVC coated unistrut or other non-corroding material.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety."

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: Perform field testing. Testing entity shall be as identified elsewhere in the Contract:

1. [Engage a qualified independent testing agency to perform specified testing.]

2. [Contractor Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

a. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Limit panelboard circuit breaker NETA injections test to 200A and above.

b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.]

C. Balancing Loads: Within 60 days of issuance of Substantial Completion, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and online data-processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: Within 60 days of issuance of Substantial Completion, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. If settings are indicated on Drawings or identified in Coordination Report, set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262417

SECTION 262500 - ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Feeder-bus assemblies.

B. Related Sections include the following:

1. Division 07 Section on "Penetration Firestopping."
2. Division 07 Section on "Joint Sealants."
3. Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety."
4. Section 260518 "Low-Voltage Electrical Power Conductors and Cables."
5. Section 260525 "Grounding and Bonding for Electrical Systems."
6. **[Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."]**

1.2 SUBMITTALS

A. Product Data: Include technical descriptions, dimensions, rated capacities, weights, finishes, and accessories for the following:

1. Feeder-bus assemblies.
2. Plug-in bus assemblies.
3. Bus plug-in devices.

B. Shop Drawings: For each type of **[bus assembly][and plug-in device]**.

1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, fire stops, weather stops, straight lengths, and fittings.
2. Indicate required clearances, method of field assembly, and location and size of each field connection. Indicate and draw special emphasis to critical dimensions and tolerances for installation of bridging joint sections.
3. Detail connections to switchgear, switchboards, transformers, and panelboards.
4. Wiring Diagrams: Power**[, signal, and control]** wiring.

5. **[Seismic-Restraint Details: Signed and sealed by a qualified professional engineer.**

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints.
b. Detail fabrication, including anchorages and attachments to structure and to supported equipment.]

C. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:

1. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
2. Clearances for access above and to the side of enclosed bus assemblies.
3. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

D. Product Certificates: For each type of enclosed bus assembly, signed by product manufacturer.

E. [Manufacturer Seismic Qualification Certification: Submit certification that enclosed bus assemblies,[plug-in devices,] accessories, and components will withstand seismic forces defined in Division 26 Section on "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.]

F. Qualification Data: For professional engineer.

G. Field quality-control documentation. Refer to Part 3 Article on FIELD QUALITY CONTROL.

1. Test Reports:

a. Notations on inspection of installation.
b. Notations on compliance on installation with manufacturer’s requirements and approved shop drawings.
c. Infrared Scanning: Documentation on infrared scanning device calibration. Provide data from required scans.

2. Certifications:

   a. Critical installation details.
   b. Compliance with NETA ATS test parameters.
   c. Report of results from this field service including certification that the busway installation fully complies with manufacturer's requirements and recommendation
   d. Certified report identifying bus assembly checked and describing results of infrared scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

H. Operation and Maintenance Data: For enclosed bus assemblies, include the following in the Systems Manual:

   1. Routine inspection and re-torquing requirements as recommended by the manufacturer.
   2. Data for critical elements required in Part 3 Article on FIELD QUALITY CONTROL, which tracks the periodic torquing of bridging sections of busway and the periodic infrared scanning of the bridging sections and busway in general. Submit in spreadsheet format.

      a. Bolt torquing data: List each bridge joint section, its torque values left, dates of initial and recheck of bolt torques, any loosening/retightening of bolt events for any reason, and initials of person doing the operation. Foot notes shall list manufacturer's acceptable torque ranges.
      b. Infrared Scan data: List each bridge joint section, its scan temperature, dates scans were taken, and initials of the person doing the scan.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed bus assemblies through one source from a single manufacturer.

B. Qualification for Electrical Professional Engineer: Engineer shall possess valid, current, professional registration issued in the United States or host country, and competent is subject matter of this Section.

C. Comply with UL 857, "Busways."

D. Comply with requirements of the OBO Electrical Code (NFPA 70, "National Electrical Code as amended by OBO).

   1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, Article 100 by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 Volts or Less."

1.5 PROJECT CONDITIONS

A. Derate enclosed bus assemblies for continuous operation at indicated ampere ratings for ambient temperature not exceeding 40 deg C.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified electrical professional engineer to design enclosed bus assemblies, plug-in devices, and components.

2.2 ENCLOSED BUS ASSEMBLIES

A. Feeder-Bus Assemblies: UL 857, low-impedance bus assemblies in nonventilated housing, single-bolt joints, ratings as indicated.

1. Voltage: **[380/220]** Volts; 3 phase; 100 percent neutral capacity.
2. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
3. Bus Materials: Current-carrying copper conductors, fully insulated with minimum Class B 130 deg C insulation except at joints; plated surface at joints.
4. Ground:
   a. 50 percent capacity internal busbar of material matching bus material.
5. Enclosure: Aluminum or steel with manufacturer's standard enamel finish.
6. Fittings and Accessories: Manufacturer's standard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.

1. **[Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section on "Vibration and Seismic Controls for Electrical Systems."]**

2. **[Design each fastener and support to carry 90 kg or 4 times the weight of bus assembly, whichever is greater.**
3. **Support bus assembly to prevent twisting from eccentric loading.**
4. **Support bus assembly with not less than 10-mm steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.**
5. **Fasten supports securely to building structure according to Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety."]**
6. Carefully install successive sections of busway in manner to prevent damage or compromise of component integrity (e.g., damage to insulation) which may cause future failure of the busway or its components.

B. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed 90 percent of manufacturer's recommended distance between fittings.

C. Install firestop fittings where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Division 07 Section on "Penetration Firestopping," and as directed by authorities having jurisdiction.

D. Install appropriate weatherseal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Division 07 Section on "Joint Sealants" for materials and application.

E. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.

F. Tighten bus-assembly bridging joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Recheck and re-torque all joints again after bus assemblies have been energized for 30 days and again just before Substantial Completion of the project. Record data on O&M data spreadsheet identified in Part 1 Article on SUBMITTALS.

G. Furnish and install one-time use multiple point temperature indicating labels on each bridging joint section.

1. These shall be self-stick labels with at least six temperature points that change color permanently when their temperature reaches its indicated value.
2. The range of temperature values selected shall be determined after consulting the manufacturer; the highest two values shall be that which indicates that the joint exceeded its recommended operating temperature.
3. Install labels after testing.
4. Labels shall be located for easy visibility by maintenance staff.
5. Furnish 20 percent extra labels as extra material.

3.2 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect busway and component installation.
2. Verify installation complies with all aspects of manufacturer’s requirements and complies with approved shop drawings.
3. Certify critical installation details such as component spacings (especially those associated with the bridge joints), adjustments, adequate support, and proper torquing of bolts affecting electrical joint conductivity have been done properly in compliance with manufacturer’s requirements.
4. Certify that the busway installation fully complies with manufacturer’s requirements and recommendations.

B. Perform the following field tests and inspections:

1. After installing enclosed bus assemblies and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection identified in NETA ATS, Section 7.4. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Within 60 days of issuance of Substantial Completion, perform an infrared scan of bus assembly including joints and plug-in units.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values.
2. Perform two follow-up infrared scans of bus assembly, one at four months and the other at 11 months after Substantial Completion.

E. Record data of critical elements:

1. Bolt torquing data.
2. Infrared Scan data.

3.4 ADJUSTING

A. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings as indicated.

3.5 CLEANING

A. After completing system installation, clean enclosed bus assemblies, supports, and accessories. Inspect exposed finishes and repair damaged finishes. Remove scratches, burrs, and surface defects.

3.6 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 262500

SECTION 262725 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Ground-fault circuit interrupters.
2. Single-standard-grade receptacles.
3. USB receptacles.
4. GFCI receptacles, 125 V, 20 A.
5. Twist-locking receptacles.
6. Pendant cord-connector devices.
7. Cord and plug sets.
8. Toggle switches and dimmer switches.
9. Device wall plates.
10. Floor service outlets
11. Multioutlet assemblies.

B. Related Sections include the following:

1. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
2. Section 260525 “Grounding and Bonding for Electrical Systems.”
3. Section 260935 “Centralized Dimming Controls.”
4. Division 27 Sections for audio-visual devices for coordination with various multimedia applications, including audio and visual devices.
5. Section 280508 “Common Work Results for Technical Security Systems (TSS)” and related Division 28 TSS subsystem Sections for additional electrical infrastructure requirements, for deterrent, detection, and response systems, and Security Management Systems Enterprise (SMSe).” This Section includes interface between Technical Security Systems (TSS) and general electrical systems.

1.3 TECHNOLOGY RESTRICTIONS

A. In accordance with Chapter 1 of the OBO Electrical Code, switches may not contain ultrasonic technology, or wireless technology, even if not implemented. This includes prohibition of Wi-Fi, Bluetooth, Near Field Communication, ZigBee, Low Power Wide Area Networks, and similar technology.

B. Floor mounted receptacles are not permitted in CAA.

1.4 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. DFCI: Dual function circuit interrupters; utilize both GFCI and AFCI detection technology.

C. BAS: Building automation system.

D. EMI: Electromagnetic interference.

E. GFCI: Ground-fault circuit interrupter, unless noted otherwise or different definition clear from context.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

B. Comply with the requirements of the OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.7 COORDINATION

A. Receptacles for Government-Furnished Equipment (GFE):

1. General GFE: Match plug configurations where known. Otherwise, provide cord and plug sets matching equipment requirements.
2. Electrified Furniture (GFE Furniture) Wiring System:

a. 8 wire or 10 wire as coordinated with GFE.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Comply with the following standards:

1. NEMA WD 1 and NEMA WD 6.
2. UL 498.

B. Wiring Devices:

1. Provide U.S. NEMA type wiring devices and associated devices, boxes, and covers in CAA, and as indicated on Construction Drawings.
2. Outside CAA all wiring devices shall be U.S. NEMA type. Receptacles other than 125-volt or 250-volt general-purpose convenience outlets shall be marked on cover plates with voltage, amperage, phase, and frequency.
3. Provide matching plugs; plugs shall conform to UL 498.

C. Wire and Cable:

1. Select types of insulation according to application.
2. Refer to OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO) for insulation types, operating temperatures, ambient temperature, and voltage classes.
3. Cable and wire sizes, types, and insulation shall be in accordance with U.S. standards to obtain suitable quality transmission for security, data, and other signal cables.
4. Provide solid conductors for conductors sized 6.0 mm^2 and smaller.
5. Provide stranded conductors for conductors sized 10 mm^2 and larger.
6. Provide copper branch circuits and feeder conductors sized at 125 percent of full load capacity.
7. Use full-sized neutral conductor and separate ground conductor for each circuit.
8. Circuits and feeders that supply power for electronic equipment may require oversized neutral to compensate for high harmonic neutral currents; such feeders shall be identified and neutral increased to minimum of two times full rated size.
9. Non-metallic sheathed cable (“Romex”), and armored or metal clad cable, Types AC or MC are prohibited.

2.2 RECEPTACLES

A. Receptacles, General: General-purpose receptacles shall be installed on 15 and 20-amp branch circuits and shall be of grounding type with effective grounding contacts. NEMA type receptacles shall be used in all spaces. GFCI protection shall be provided for receptacles in restrooms, bathrooms, kitchen, other wet areas, and outdoors in accordance with the OBO Electrical Code and NFPA 70.

1. Local standard receptacles may be used where approved by OBO/PDCS/DE/EE. Where used, they shall be rated 220V, 16-A; receptacles rated 220V, 10-A or 13-A are not permitted.

B. Straight-Blade and Twist Locking Receptacles: Heavy-Duty grade. NEMA 6-20R for 220V, 230V, or 240V applications.

1. Exception for TSS: All TSS equipment racks shall be provided with NEMA L6-30R receptacles supplied by nominal 200 to 240 volt single phase power. See TSS Electrical Distribution Design Guidance for specific connection details.

C. NEMA 6-20R Neutral Pin Polarization: NEMA 6-20R receptacles rated at 250 volts used on 2-pole, 3-wire grounding system (380Y/220, 400Y/230 or 415Y/240 volt) systems, shall have T-shaped slot of the receptacle used for connection of white neutral wire

D. GFCI receptacles shall not be used for 220V receptacles. Outlets designated for GFCI protection shall be fed from general-use non-time delay GFCI breaker; mount either within panelboard or in residual current device (RCD) enclosure adjacent to panelboard feeding branch circuit.

E. AFCI receptacles are not permitted. Outlets designed for AFCI protection shall be fed from AFCI circuit breaker mounted within panelboards.

1. Exception: Use of AFCI and DFCI breakers and circuits is only permitted for residential uses for 125V, 60 Hz applications in accordance with NFPA 70.

F. Provide one 20-A and one 15-A cord plug cap for each duplex receptacle, and two of each for each quadraplex receptacle. Plug caps shall be of grounding type, utilizing only screw terminals for terminating conductors.

G. Receptacles used for floor outlets shall have GFCI circuit protection, and shall conform to requirements for as wet locations.

2.3 USB RECEPTACLES

A. USB Charging Receptacles :

1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles:

a. Type-A: Dual and quad, USB Type-A, 5 V DC, and 2.1 A per receptacle (minimum).
b. Type-C: Dual and quad, USB Type-C, capable of delivering 5 V to 20 V DC, and 3.0 A to 5.0 A per receptacle (minimum) based on Power Delivery (PD) specifications.

3. Standards:

a. USB Type-A: Comply with UL 1310 and USB 3.0 devices.
b. USB Type-C: Comply with UL 1310, USB 3.1/3.2, and USB Power Delivery (PD) 2.0/3.0 standards.

2.4 SWITCHES

A. Single- and Double-Pole Switches, Three Way and Four Way: Comply with UL 20 and FS W-S-896.

B. Snap Switches: Heavy-Duty grade, quiet type; comply with UL 20.

C. Dimmer Switches: Comply with UL1472 – Solid-State Dimming Controls Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.

1. Control: **[Provide full range, continuously variable control of light intensity, and flicker free operation. Continuously adjustable slider; with single-pole or three-way switching to suit connections.]**
2. Operate at rated capacity across full ambient temperature range including modified capacities for ganging configurations which require removal of fins. Operation at rated capacity shall be possible across full ambient temperature range, without shortening design lifetime.
3. Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption for minimum period of two years.
4. When dimmer switch is in “off’ position, load shall be fully disconnected from line supply eliminating any leakage current.
5. Withstand electrostatic discharges up to 16,000 volts without impairment per IEC 801-2.
6. Withstand line-side surges without impairment to performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41C.
7. Provide preset 3-way control from the dimmer location regardless of the position of other 3-way switch location.
8. Standards: Comply with UL 1472.

D. Pilot-Light, Single-Pole Switches:

1. Description: Illuminated when switch is on.
2. Standards: Comply with UL 20 and FS W-S-896.

E. Lighted Single-Pole Switches:

1. Description: Handle illuminated when switch is on.
2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

F. Key-Operated, Single-Pole Switches:

1. Description: Factory-supplied key in lieu of switch handle.
2. Standards: Comply with UL 20 and FS W-S-896.

G. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches:

1. Description: For use with mechanically held lighting contactors.
2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.5 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces. Refer to Construction Drawings for selected finish by space. The following are requirements for type of selected material:

   a. Steel with white baked enamel, suitable for field painting.
   b. Smooth, high-impact thermoplastic.
   c. 1-mm- thick, satin-finished, Type 302 stainless steel.
   d. 1-mm- thick, brushed brass with factory polymer finish.
   e. 1.2-mm- thick, anodized aluminum.
   f. 1-mm- thick steel with chrome-plated finish.

3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum.

D. Antimicrobial Cover Plates:

1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2. Tarnish resistant.

2.6 FLOOR SERVICE FITTINGS

A. Floor service fittings are discouraged. Requests for limited use shall be submitted to Project Director/COR for approval with input from OBO/PDCS/DE/EE electrical engineer.

1. Refer to Article on TECHNOLOGY RESTRICTIONS regarding floor mounted receptacles.
2. Type: Modular, flush-type, dual-service units suitable for wiring method used.
3. Power Receptacle: NEMA, Configuration 6-20R, unless otherwise indicated or scheduled. Colors shall match interior color scheme approved by the Project Director/COR.
4. Signal Outlet: Blank cover with bushed cable opening, unless otherwise indicated or scheduled.
5. Floor mounted fittings shall be Ground Fault protected.

2.7 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

B. Wire: 4.0 mm^2.

2.8 FINISHES

A. Devices and face plates shall match or be provided as below **[or in accordance with wall plate and device finish schedule]**. Single and combination types shall match corresponding wiring devices.

1. Face Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: **[Provide in accordance with wall plate and device finish schedule][Gray device][1-mm- thick, brushed stainless steel]**.
3. Material for Unfinished Spaces: Gray device; Galvanized steel face plate.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that cover plate does not cross joint unless joint is troweled flush with face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

B. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall comply with model NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided outlet box is large enough.

C. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package, or otherwise protect until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 150 mm (6 inches) in length.
5. When there is choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of way around terminal screw.
6. Use torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than $4mm^2$ are installed on 15- or 20-A circuits, splice 4mm2 pigtails for device connections.
8. Tighten unused terminal screws on device.
9. When mounting into metal boxes, remove fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

D. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

E. Install devices and assemblies level, plumb, and square with building lines. Comply with NECA 1.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush, or when they do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Define each dimmer’s load type, assign each load to a zone, and set control functions.
3. Verify that dimmers used for fan-speed control are listed for that application.
4. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in written instructions

H. Install equipment in accordance with manufacturer’s installation instructions.

I. Provide equipment at locations and in quantities indicated on drawings. Provide any additional equipment required to provide control intent.

J. Perform full-function testing on all completed assemblies. Statistical sampling is not acceptable.

K. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.

L. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.

M. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates where possible.

N. Remove wall plates and protect devices and assemblies during painting.

O. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 MULTIMEDIA RECEPTACLE INSTALLATION

A. Where wall mounting is indicated or scheduled for various multimedia devices (e.g., flat panel displays), locate receptacles as follows:

1. Coordinate for elevation above finished floor.
2. Coordinate with mounting elements for multimedia devices, including brackets and hardware, and wall blocking.
3. Install with recessed receptacle boxes behind mounting hardware to allow for relief of plug and cord.

3.3 IDENTIFICATION

A. Comply with Division 26 Section on "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
2. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

3.4 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436 as applicable.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following field tests and inspections and prepare test reports:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
3. Test AFCI operation with both local and remote fault simulations according to manufacturer’s written instructions.

D. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 262725

SECTION 263105 – SOLAR PHOTOVOLTAIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes photovoltaic (PV) panels and their associated mounting systems, photovoltaic system inverters, and associated Data Acquisition System (DAS). PV system applications for this project include:

1. [Flat rooftop installation.]
2. [Covered parking and covered walkway installation.]
3. [Ground mounted installation]

B. [This project involves installing PV system on existing structure.]

C. Related Sections include the following:

1. Section 230905 “Instrumentation and Controls for HVAC.”
2. Section 260508 “Common Work Results for Electrical, Communications and Electronic Safety.”
3. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
4. Section 260525 “Grounding and Bonding for Electrical Systems.”
5. Division 26 Section on raceways and boxes.
6. Section 260915 “Electrical Power Monitoring.”
7. Division 26 Section on enclosed switches and circuit breakers.
8. Section 262214 “Low-Voltage Transformers.”
9. [Division 26 Section on Energy Storage Systems.]

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):

1. C12.1: Standard for Electricity Meters.
2. C12.20: Standard for Electrical Meters.

B. American Society for Testing and Materials International (ASTM)

1. E1890: Standard Test Methods for Determining Integrity of Photovoltaic Modules

C. The Institute of Electrical and Electronics Engineers, Inc (IEEE):

1. IEEE 929: Recommended Practice for Utility Interface of Intermediate PV Systems.
2. IEEE 80: Recommended Grounding Practices.
3. IEEE 1547: Standard for Interconnecting Distributed Resources with Electric Power Systems.

4. IEEE 1547.1: Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.

D. Underwriters Laboratories, Inc. (UL):

1. 96: Lightning Protection Components.
2. 1741: Standard for Safety for Static Inverters, Converters, Controllers and Interconnection System Equipment for Use in Photovoltaic Power Systems.
3. 1703: Standard for Flat-Plate Photovoltaic Modules and Panels.
4. 2703: Rack Mounting Systems and Clamping Devices for Flat-Plate Photovoltaic Modules and Panels.
5. 61215: Standard for Terrestrial Photovoltaic (PV) Modules

E. 61730: Standard for Photovoltaic (PV) Module Safety Qualification International Electrotechnical Commission (IEC)

1. 61000-30 – Testing and Measurement Techniques.
2. 61215 - Terrestrial photovoltaic (PV) modules.
3. 61730 - Photovoltaic (PV) module safety qualification.
4. 61727 - Photovoltaic (PV) systems - Characteristics of the utility interface.
5. 62109-1/2 - Safety of Power Converters for Use in Photovoltaic Power Systems.
6. 61683 - Power conditioners – Procedure for measuring efficiency.
7. 62116 - Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures.

F. National Fire Protection Association

1. 780: Standard for the Installation of Lightning Protection Systems.

G. National Electrical Installation Standards (NEiS)

1. NECA 412 “Std for Installing & Maintaining PV Power Systems.”

H. OBO Electrical Code (NFPA 70, "National Electrical Code" including amendments by OBO); reference Article 690 and other Articles as applicable.

I. OBO Fire Code (International Fire Code including amendments by OBO); applicable provisions include but are not limited to model code Section 1204.

1.3 SUBMITTALS

A. Product Data: Submit for panels, mounting hardware, inverters, Data Acquisition System (DAS), accessories, and components indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Site Parameters Report: Submit report identifying environmental and bioclimatic conditions at site including, but not limited to, solar irradiation, solar insolation, altitude, humidity,

temperatures, assumed PV array temperature adjustments for mounting conditions, and seasonal ambient conditions that impact energy production of PV system.

C. System Performance estimate: AC kWh energy production estimation: Provide per the following web sites or software programs or approved equal.

1. RETScreen® International: www.retscreen.net/ang/d_o_view.php
2. PVSYST: www.pvsyst.com

D. Shop Drawings: For PV system and related equipment, submit the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. PV System Array and Equipment Layouts.
   b. Total system rated capacity and total system nominal capacity in kW including subtotals by area.
   c. Mounting system.
   d. Sections and Elevations.
   e. Roof Penetrations.
   f. Construction Staging and Storage Areas.
   g. Test Reports.
   h. System Weight, including subtotals by area.

2. Wiring Diagrams: Submit complete single-line and wiring diagrams indicating required power, signal, monitoring, and control wiring. Include all schematic diagrams, overcurrent protection sizes, wire sizes, and similar information. Wiring diagrams shall differentiate between manufacturer-installed and field-installed wiring details.

E. Data Acquisition System (DAS): For DAS, submit the following product data:

1. Technical specifications for measurement devices to be utilized.
2. Catalog cut sheets of all devices to be used. Clearly indicate which model number is being submitted on all cut sheets.
3. Technical specifications for all types of wires to be provided.
4. One example of charts and reports.
5. Identification of deviations from materials or methods described in this Section for DAS.
6. Proofs of all display screens for DAS for Government review and approval. Refer to Part 2 Article on DATA ACQUISITION SYSTEM.

F. Structural Certification: Certification by licensed structural engineer demonstrating ability of a structure to support all loads required for PV system.

G. Factory Test Reports: PV modules, racking system and inverters.

H. Field Test Reports: Submit written test reports; include the following:

1. Test procedures used.

2. Final Test results. Include all test results and demonstrate their comparison to and compliance with requirements.
3. Report shall include results of all failed tests and corrective action taken to achieve test results that comply with requirements.

I. Operation and Maintenance Manuals:

1. In addition to the items specified in Division 01, Section 017825 Systems Manual and O&M Data include the following documentation:

a. Each item of equipment and each system: Include description of unit or system, and component parts. Give function, normal operating characteristics, and limiting conditions. Include commercial number of replaceable parts.
b. Provide approved engineering submittals. Include equipment sizing calculations.
c. Provide manufacturer's installation wiring diagrams and schematic diagrams.
d. Operating procedures: Include routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instruction. Include summer, winter, and any special operating instructions.
e. Maintenance requirements: Include required materials, routine procedures and guide for cleaning, troubleshooting, equipment isolation, AC and DC lockout, tagout, and repairing PV Modules including disassembly, repair and reassembly instructions, alignment, adjusting, balancing, and checking instructions. Include procedures for testing printed circuit boards, cells, and modules
f. For field installed circuits, include color coded wiring diagrams and schematic diagrams with wire functions labeled on the diagrams.
g. For adjustable mounting systems, include the preferred mounting angle of PV Modules for summer and winter optimum performance.
h. Provide a screen shot of each display page of DAS output.
i. For PV systems with PV Modules installed in a manner that limits maintenance access to less than two sides of each PV modules, provide preferred method for preventing undesirable vegetation around PV Modules and for protecting the PV Modules while removing vegetation around PV Modules.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain PV modules from single manufacturer. Mounting for PV system specified in this Section shall be from single manufacturer. PV system inverters shall be from single manufacturer. DC combiner boxes shall be from a single manufacturer. DC disconnects shall be from a single manufacturer. AC combiner panels shall be from single manufacturer. PV system isolation transformers shall be from single manufacturer.

1. [The use of multiple manufacturers where custom detailing of visible portions with aesthetic consideration of the PV system panel installation, shall be permitted with approval by Project Director/COR.]

B. Manufacturer: Manufacturer of any PV equipment shall be a company specializing in manufacturer of PV equipment and have documented experience with their hardware in commercial applications in field.

C. Listing and Labeling: Electrical components, devices, and accessories, Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

D. Certificate of Compliance: Provide certificate of compliance to referenced standards from manufacturer of PV Systems.

E. Qualifications:

1. Installation Personnel: Submits evidence prior to work that persons who are to perform work herein have appropriate training or experience in PV system installation, design, and applicable safety procedures, and hold proper licenses where applicable.
2. Commissioning Personnel: Provide qualifications including experience of personnel responsible for PV system startup and commissioning work.

F. Pre-installation Conference: Before installation of PV system begins, conduct pre-installation conference at project site with installers, and other interested parties to review procedures, schedules, safety and coordination of installation with other elements of the work. Contractor shall notify Project Director/COR of anticipated date of this conference at least three weeks prior to meeting. Several conferences may be needed, depending upon system complexities and construction schedule.

G. All materials supplied for this project shall be new.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and receive all PV system materials required for the work.

B. Prior to and during construction, provide secure storage on site for all PV system materials stored on site.

C. Store and handle to comply with manufacturer's directions, and as required to prevent damage to glass, PV materials, and system component electronics.

D. If stored in areas subjected to weather, cover PV modules and system component electronics to provide protection from weather, dirt, dust, corrosive substances, and physical damage.

E. Replace any scratched or damaged PV system materials or system components.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following site-specific conditions, unless otherwise indicated:

1. Temperatures:

   a. Annual Ambient: **[enter site specific value]** deg C to **[enter site specific value]** deg C.
   b. Record low temperature: **[enter site specific value]** deg C.
   c. Maximum monthly high temperatures (to determine PV string length):

      January **[enter site specific value]** deg C.
      February **[enter site specific value]** deg C.
      March **[enter site specific value]** deg C.
      April **[enter site specific value]** deg C.
      May **[enter site specific value]** deg C.
      June **[enter site specific value]** deg C.
      July **[enter site specific value]** deg C.
      August **[enter site specific value]** deg C.
      September **[enter site specific value]** deg C.
      October **[enter site specific value]** deg C.
      November **[enter site specific value]** deg C.
      December **[enter site specific value]** deg C.

2. Altitude: **[Sea level]**,**[enter site specific value]**.
3. Relative humidity: **[enter site specific value]**,**[Up to 100% non-condensing]**.
4. **[enter other site-specific conditions such as wind ratings, sand/dust, seismic activity, salt air, fog, marine corrosiveness, etc.]**

1.7 COORDINATION

A. Coordinate layout and installation of PV System and components with other construction, including conduit, piping, equipment, roof drains, roof penetrations, antennas, and adjacent obstructions and surfaces. Maintain required clearances for workspace and equipment access.

B. Coordinate size and locations of mounting bases and casting of anchor-bolt inserts into concrete slabs, beams and columns.

C. Coordinate location of ballast support rails with existing structural framing.

D. Coordinate system with structural capability of roof structure. Coordination of loading from PV mounting system with design of main building is responsibility of Structural Engineer of Record.

E. Coordinate Roof Slope and outfall: Project-specific application will define PV system slope; however, coordinate mounting system with roof slope and drainage arrangement (gutter/downspout/sheetflow) toward suitable outfall.

F. Coordination with roof membrane: Contractor shall coordinate type, thickness, and construction of roof membrane. PV System shall be able to function with installed roof membrane and not create leaks in roof. Contractor shall ensure that PV system does not cause roof to leak. **[For separate PV projects, it is responsibility of PV contractor to ensure roof does not leak.]**

G. Provide system technical coordination for utility interconnection agreements. Provide grid connection as required, and in location as designated by local utility company.

H. Coordinate electrical voltage, phase, and hertz characteristics of PV system's output with electrical characteristics of local utility company. Provide isolation transformers where indicated to **[step-up]**, **[step-down]** PV system output voltage to match local utility company's voltage.

1.8 WARRANTIES

A. General: Provide 5 years of technical phone support for technicians and designated maintenance personnel for PV system components and Data Acquisition System (DAS) from the date of Substantial Completion.

B. Mono or Polycrystalline PV Modules (bifacial and monofacial type): From the date of Substantial Completion, PV modules installed in system shall have 10-year materials and workmanship warranty, and PV modules shall have a 25-year service warranty to exhibit power output of not less than 80 percent of rated power . If during the service warranty period, any of the PV modules exhibits power output of less than 80 percent, manufacturer shall replace the affected modules. Refer to Article on COMMISSIONING.

C. Power Conditioning Equipment: Power conditioning equipment shall have 10-year product warranty from the date of Substantial Completion. During warranty period, manufacturer shall repair or replace power conditioning unit. Warranty shall include on-site troubleshooting completed by local electrician with phone support from equipment manufacturer.

D. Data Acquisition Equipment: Data acquisition equipment shall have a 5-year product warranty from the date of Substantial Completion, with option to purchase -ten-year warranty. During warranty period, manufacturer shall repair or replace the unit. Warranty shall include on-site troubleshooting completed by local electrician with phone support from equipment manufacturer.

E. [Existing structures: Existing roof is under warranty at start of PV system installation. Contractor shall coordinate and work with existing roof warranty provider to uphold and maintain existing roof warranty during and after PV system retrofit.]

1.9 EXTRA MATERIALS

A. Based upon systems used for this project, furnish extra materials described below that match products installed, packaged with protective covering for storage, and identified with labels describing contents.

1. PV modules: Quantity of modules to meet 1.5 percent of total PV system size, or no less than three modules.
2. String Inverters: Two per inverter model used for the PV system.
3. DC combiner and disconnect fuses: Quantity of fuses to meet 5 percent of the total installed quantity.
4. PV module connectors: Quantity of connectors to meet 5 percent of the total installed quantity.

5. Bypass Diodes: Quantity of diodes to meet 2 percent of the total installed quantity.

1.10 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date for a period of one calendar year with a renewable option for an additional year, provide proposal for system maintenance service based on manufacturer's recommended daily, weekly, quarterly, semi-annual, and annual maintenance activities. The proposal shall be submitted to the COR/Project Director at least 120 days prior to Substantial Completion.

B. The intent is to provide full maintenance service.

C. Maintenance service shall include preventive maintenance, repair or replacement of worn or defective components, required supply of cleaning solutions,**[performing scheduled cleaning,]** and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks shall also align with the manufacturer's recommended checklists as required in Division 01 Section 017825 "Systems Manual and O&M Data." Provide completed maintenance records inclusive of scheduling to the USG for inclusion in the CMMS.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE REQUIREMENTS

A. Photovoltaic Modules:

1. The PV modules shall be framed flat-plate crystalline or polycrystalline **[monofacial][bifacial]** silicone modules.
2. PTC ratings shall not be less than 11.5% of the rated nameplate power output.
3. The PV modules shall meet or exceed the requirements of UL 1703 and IEC 61215
4. The PV arrays shall be sized to achieve the production of electrical (kWh) AC power noted on the drawings within the area specified on plan. The indicated rating shall be based upon the PTC rating of the modules.

B. Product selection for mounting:

1. Support PV systems associated with new construction by structure using fixed mounted system as specified herein and in the contract documents.
2. **[Support PV systems associated with existing structures by ballast-mounted non-penetrating system as specified herein and in contract documents. Vertical, lateral, and overturning forces with PV system shall be resisted by ballasted roof system mounting system.]**
3. **[Support PV systems associated with new construction of covered parking by structure using fixed mounted system as specified herein and in contract documents.]**
4. **[Support PV systems associated with new construction of walkway canopies by structure using fixed mounted system as specified herein and in contract documents.]**

5. **[Support PV systems associated with new construction of ground mounted system by structure using fixed mounted system as specified herein and in contract documents.]**

C. Side Voltages: Conform to limitations identified in NFPA 70.

D. Structural Performance: Provide mounting systems capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Design Loads: As indicated on Drawings and required in Chapter 16 of the OBO Building Code (International Building Code as amended by OBO), including referenced ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
2. Dead Loads: Include vertical loads induced by the PV system and their associated mounting systems, as well as personnel access where applicable.
3. Roof Snow Loads: Include vertical loads induced by weights of snow based on loads identified for project, or Chapter 16 of the OBO Building Code if not identified. Allow for unbalanced and drift loads in design.
4. Wind Loads: Include horizontal loads and uplift induced by basic wind speed corresponding to mean-recurrence interval at Project site based upon loads identified for project, or Chapter 16 of the OBO Building Code if not identified.
5. Seismic Loads: Include horizontal loads induced by effects of earthquake motions in accordance with Chapter 16 of the OBO Building Code, including referenced ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
6. Load combinations: Design mounting system to withstand most critical effects of load factors and load combinations as required by Chapter 16 of the OBO Building Code, including referenced ASCE 7, "Minimum Design Loads for Buildings and Other Structures." **[For existing structures, analyze if adequate to support PV system and associated mounting system to withstand most critical effects of load factors and load combinations as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures."]**

2.2 MANUFACTURERS

A. PV Module Manufacturers: Equipment manufacturers are subject to meeting the specified performance requirements within this document.

B. String Inverter Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. SMA America, Rocklin, CA.
2. Schneider Electric.

C. Central Inverter Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. SMA America, Rocklin, CA.
2. Schneider Electric.

D. Combiner/Collector Box Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. SMA America, Rocklin, CA.
2. SolarBOS Corp, Livermore, CA.
3. Bentek Corp., San Jose, CA.

2.3 GENERAL

A. PV module Electrical Termination: Potted block with factory installed positive and negative Multi-Contact MC4 connectors as indicated on the contract drawings or an approved equal.

B. [Thin Film PV module Electrical Termination: Edge termination with factory installed positive and negative Multi-Contact MC4 connectors as indicated on the contract drawings or an approved equal.]

C. All cell interconnections on all types of PVs shall be made with the encapsulation.

D. Diodes: All PV Modules shall be supplied with factory installed by-pass diodes.

E. Single Phase String Inverters: Match inverter frequency to local utility company frequency. Match inverter output voltage to local utility company utilization voltage. **[Provide isolation transformers where indicated to match PV system voltage to local utility voltage.]**

F. Three Phase String Inverters: Match inverter frequency to local utility company frequency. Match inverter output voltage to local utility company utilization voltage. **[Provide isolation transformers where indicated to match PV system voltage to local utility voltage.]**

G. Three Phase Central Inverters: Match inverter frequency to local utility company frequency. Match inverter output voltage to local utility company utilization voltage. **[Provide isolation transformers where indicated to match PV system voltage to local utility voltage.]**

H. Provide AC disconnect switches to building power distribution system.

I. Isolation Transformer: Provide isolation transformer and associated disconnect switches between AC collector boxes and building power distribution system connection, where these are not integral to the Inverter(s).

J. Power line conditioners: Provide power line conditioners between AC collector boxes and building power distribution system connection to minimize ground currents on facility electrical system and to reduce electromagnetic interference (EMI) and Radio Frequency Interference (RFI) on power lines. Filters may be integrated into inverters.

K. Exposed Conduit: All exterior exposed conduits shall be galvanized rigid steel (RMC) with threaded fittings.

L. Disconnect Switches: Provide AC and DC disconnect switches as required.

M. PV Module and PV Wire Connectors: Provide connectors as recommended by manufacturer. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Multi-Contact
2. Tyco
3. Huber+Suhner

N. PV system Output: Where grid tied PV systems are acceptable to local utility company, PV system's inverters shall match local utility company exactly in voltage, phase, and frequency to allow it to be grid-tied in accordance with local utility company's safety and power quality requirements. **[PV system shall not produce energy in excess of what will be consumed at site. Provide and arrange revenue meter where PV system generated energy is not registered on utility meter.] [PV system may produce energy in excess of what will be consumed at site. Provide net metering at utility meter to account for PV system generated power being registered on utility meter for power generation credit.] [PV system may produce energy in excess of what will be consumed at site. Provide revenue metering at utility meter to account for PV system generated power being registered on utility meter for power generation credit based upon time of day and PV power generated.]** Coordinate all requirements with local utility company. Refer to Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety" for additional metering requirements. Provide safety disconnect switches to disconnect PV system from local utility line in event of utility failure, complying with utility requirements.

O. Internet Connectivity: Contractor shall provide cellular modems and balance of equipment, allowing for GSM/GPRS remote monitoring of PV system data logging. Cellular service will be established and maintained by post. No device or system may be permitted to have or require internet connectivity to function. There will be no connectivity to internet or intranet.

P. Battery Storage: Battery storage system, as required as part of PV system, shall be fully enclosed cabinets, **[complying with Division 26 Section on Energy Storage Systems],** and shall be listed for application in accordance with OBO-ICS NEC Chapters 1 and 7.

Q. Electrical materials must be durable for the expected life of the systems (25 years). This shall include but not be limited to; material selection for structural elements, **[corrosive resistant coatings for members and connections (bolts, nuts, washers, etc.), high temperature ratings for electrical equipment (to include additional heat dispersion methods)],** protective coatings for conduits and cablings.

R. [Integrate the PV system with the existing electrical distribution system, matching system voltages and electrical characteristics]

2.4 ROOF MOUNTING SYSTEMS

A. Fixed mounted supported systems.

1. Support PV system with fixed mounted system for new construction or in conjunction with complete roof replacement. Design support system for maximum span lengths and

minimum roof penetrations. Attach mounting system to structure using post-installed anchors, embedded anchors or as indicated in contract documents. Provide minimum stand-off height above roof surface that is required for roof system and mounting system as well as inspection and maintenance.

2. Flash fixed mounted support systems in accordance with "The NRCA Roofing and Waterproofing Manual" recommendations for type of roofing system being affected. All flashing and penetrations shall be inspected by roofing supplier/contractor and warrantied with roof system.

B. [Ballast mounted support systems.

1. Support PV systems with ballast-mounted system on existing buildings. Design support system to resist overturning and sliding effects from wind and seismic loads. Do not penetrate roof deck or roofing material. Structural Engineer of Record shall verify existing structure has capacity to support load from ballast mounting system. Verify roof deck and roofing material can support ballast system without damage to either.

2. Alternate mounting systems may be submitted for review with explanation and justification for such system. Include design calculations supporting justifications. All deviations in systems, materials and methods must receive written approval from Project Director/COR based upon input from OBO/PDCS/DE/EE.]

2.5 [COVERED PARKING AND COVERED WALKWAY ARRAY COMPONENTS

A. Covered parking and covered walkway PV system shall include an array of contract-specified PV Modules, mounted on covered walkway structure [structure by others] in such manner to secure PV array to structure. Provide PV Module to PV Module multi-connect connectors, as specified herein or an approved equal.

1. Canopies shall be designed to allow for underside access of all serviceable components including, but not limited to, wiring and modules. Systems shall not require overhead access for module replacement.

2. Canopies which are designed without underside access shall be treated as a roof with unprotected edge in terms of requirements for temporary railings, access pathways, and personnel fall protection.]

2.6 [GROUND MOUNTED ARRAY COMPONENTS

A. Ground mounted PV system shall include array of contract-specified PV Modules mounted on fixed ground mounted structure in such as manner to secure PV array to structure. Provide PV Module to PV Module Multi-connect connectors, as specified herein or an approved equal.]

2.7 INVERTERS

A. DC-AC Inverters: Inverters shall provide output waveform to match building power distribution system when grid tied to local utility or in combination with generator operation where applicable. Inverter output shall comply with all local utility company requirements. Inverters shall be compatible with its associated PV system array output and utility input as indicated on Construction Drawings. Inverters shall be capable of complete automatic unattended operation including start-up, synchronization, and disconnect, and operating in parallel with other inverters, utility, and generators. Voltage and frequency tolerances shall match the requirements of the local utility company or generators. The inverters shall be capable of shutting down without damage when PV array output is outside tolerance parameters of inverter, and in accordance with rapid shutdown. Manufacturer shall connect array to ground in inverter in accordance with array requirements, as indicated on Construction Drawings. Inverters shall be at minimum listed to UL1741 and compliant with IEEE 1547. Inverters shall be at minimum rated 95.5 percent efficient.

B. Power control feedback: Provide a power control feedback system to monitor the utility, standby generators (photovoltaic diesel hybrid system), and the total PV inverter output. The PV system shall be designed to optimize generator use. For facilities with diesel generators, PV output must be controlled to maximize the generator loading for greatest efficiency of generator operation (single or paralleled generator application), and to protect from back loading generators. Utility integration shall maximize power factor, as observed by the utility, to avoid power factor charges form the utility.

1. Power control feedback shall be managed from the **[energy storage system's micro-grid controller][hybrid control system]** as the primary controller.

2. **[Hybrid Control System: PV system design shall include control system allowing for hybrid operation of PV system with diesel generator systems. Control system shall automatically monitor and control all PV inverters to allow stable operation of the photovoltaic diesel hybrid system. Controller shall continuously monitor operating state of generators and loads and shall adjust output power of inverters accordingly. Possible technologies include, but are not limited to ABB PVI-PMU, SMA Fuel Save Controllers and DEIF Automatic Sustainable Controllers.]**
3. Provide return time delay of 30 seconds when utility return or generator transfer to allow clearance of fields, and address transient spikes associated with switching equipment upstream or downstream.

2.8 ACCESSORIES

A. DC Combiner Box: UL listed components and suitable for the environment in which installed with provisions for 1000Vdc or 600Vdc fuses of appropriate size for each source circuit in accordance with NFPA 70 guidelines with electrical characteristics, as indicated on Construction Drawings.

1. Combiner/Collector Boxes: DC combiner boxes shall be UL 1741 listed with required number of inputs and outputs for PV system configuration.

2. DC combiner boxes shall include control wiring and hardware required to be deenergized via shunt trip as part of rapid shutdown control requirements per OBO-ICS NEC.
3. DC combiner boxes shall be located local to each PV array to maintain compliance with rapid shutdown boundary requirements per OBO-ICS NEC.

B. Devices and enclosures shall be rated for application. Exterior installations of components shall have minimum steel NEMA **[3R][4X]** rating for exterior wet locations and project conditions. Enclose interior installations in minimum steel NEMA 1 enclosures.

C. Fabrication of supports for system components (excluding PV module support) shall be heavy-duty, self-supporting galvanized steel channel provided with captive clips for panels, boxed and conduits.

D. Cabling: All conductors, cabling, and associated connectors shall be UL listed for environmental conditions in which they will operate.

1. No fine-stranded conductors may be used for ground connections.

E. Rapid shut-down devices performing rapid shutdown complying with OBO-ICS NEC requirements and compatible with inverter(s) and power conditioning equipment, including push button and accessories for a complete solution.

2.9 DATA ACQUISITION SYSTEM

A. Provide all data acquisition system (DAS) equipment required for complete and working DAS. DAS equipment shall include all of sensors and wiring required to measure and record parameters indicated herein.

B. All equipment supplied for DAS shall have capability of operating at voltage and frequency available at installation location.

C. Integrate DAS with building automation system (BAS). Instruments and measuring equipment may report directly to BAS. DAS shall provide output to lobby display. When BAS is not available at site, provide computer for DAS of latest available technology, with latest version of Windows operating system, and with ability to share data collected by DAS system with remote computer as described in this Section, and to future BAS via RS-485/Ethernet connection.

D. The DAS shall perform the following tasks:

1. Sample listed parameters data at least 20 times per minute and log the average values to data storage area in maximum of 5-minute intervals.
2. Retain logged data upon loss of power.
3. Start logging data and reestablish network connections automatically when power is restored.
4. Generate daily and monthly files as defined herein.
5. Store logged data for a minimum of five years.

E. The following parameters shall be monitored.

1. Ambient temperature (C) shall be measured with stainless steel sheathed temperature sensor module. House temperature sensor in shielded enclosure.
2. Measure wind Speed (m/s) with approved anemometer.
3. Measure plane of array (rooftop) irradiance (W/m2) by approved PV reference cell
4. Measure module temperature with surface mounted temperature sensor (mounted on rear of module) adhered with high temperature epoxy.
5. Instantaneous voltage (V), amps (A), power (kW), and accumulated (kWh) energy output for the PV system.
6. Soiling: Soil sensor shall be used to monitor and determine soiling losses, and to optimize washing schedule.

F. Daily file shall be generated by DAS that includes, at minimum, 15-minute averaged data over entire day for each of parameters listed above in tabular format.

G. Monthly file shall be generated by DAS that include, the following parameters in tabular format presented for each day in month.

1. Daily total irradiance (kWh/m^2)
2. Total daily AC energy produced by PV system (kWh)
3. Peak AC power output for PV system (kW)
4. Average temperature for day (°C)
5. Maximum temperature for day (°C)
6. Maximum module temperature for day (°C)
7. Minimum temperature for day (°C)
8. Average wind speed for day (m/s)
9. Total calculated CO_2 abated by use of PV system.

H. DAS system shall have ability to broadcast instantaneous data onto a Ethernet TCP/IP network via MODBUS communication protocol to a datalogger. The data on the logger must be accessible through an HTML interface.

I. When there is no BAS, provide and program computer to display in a location designated by Project Director/COR, real time data that is broadcast by DAS equipment.

J. Display shall be updated at minimum of 12 times per minute, and it shall allow for flexibility in content, such that content and appearance may be changed at any time.

K. Real time display shall include in graphical format, at minimum, the following:

1. Instantaneous irradiance as measured by PV reference cell.
2. Instantaneous ambient temperature.
3. Instantaneous wind speed.
4. Combined instantaneous AC power being produced by all PV systems.
5. Total daily AC energy produced by all PV system as running sum.
6. Total year to date AC energy produced by all PV systems as running sum.
7. Total lifetime AC energy produced by all PV systems as running sum.
8. Aggregate amount of CO_2 abated by use by all PV systems as running total.

9. Alerts or alarms registering overheating in power conversion equipment, departure from reference PV cell to array output, faults or general failure of components or performance.

L. Provide an additional 1-meter (diagonal) LCD or LED Screen display, suitably equipped with mounting hardware for wall-mounted application in remote location of main office building entry lobby; exact location will be determined by Project Director/COR. The display must be a commercial model designed for continuous use. In addition, provide computer to interface with display as described herein. Computer shall communicate with BAS via RS-485/Ethernet. Computer shall be current technology with Windows 7 (or newer version) operating system, and shall have ability to support display and minimum of the following:

1. 2 GB RAM.
2. 500 GB Hard Drive.
3. 2.8 GHz Processor.
4. 10/100/1000 mbps Network card (or compatible card for building network system).
5. Keyboard and mouse.
6. Surge protection power supply.
7. Five minutes of 720 watts of battery backup with automatic shutdown on extended. outages of electrical power.

M. Provide high quality digital video cable to connect display computer with remote lobby display. Cable shall be compatible with both computer and display, and shall be installed in rigid conduit and boxes.

N. Mount remote display at maximum of 100 meters from computer. Remote display and computer shall display seven continuously cycling pages as described herein. Display time periods shall be adjustable from initial settings described below. All pages shall include appropriate graphics to convey information in addition to supporting text for each page as outlined herein. All graphics shall be reviewed and approved by the government prior to implementation. Page content is as follows:

1. Page 1: Display all real time parameters as described above. All parameters shall be updated minimum of every five seconds. Display Page 1 for two minutes.
2. Page 2: Display description of climatic conditions that are measured as described herein. Page 2 shall include description of effect of these parameters on PV system performance. Display Page 2 for 1 minute.
3. Page 3: Display description of combined instantaneous AC power output of all arrays as measured. Page 3 shall provide description of photovoltaic conversion process of sunlight into AC energy. Display Page 3 for 1 minute.
4. Page 4: Display description of daily, yearly and lifetime energy production as calculated herein. Page 4 shall describe basic unit of electrical energy and example of how energy produced is related to climactic conditions. Display Page 4 for 1 minute.
5. Page 5: Display aggregate amount of CO_2 abated from atmosphere from use of PV system, as well as description of methods of calculating these figures. Display Page 5 for 1 minute.
6. Page 6: Display estimate of number typical households or local equivalent that could be powered by expected annual energy harvest of entire array for installation as defined by Construction Drawings. Display Page 6 for 1 minute.

7. Page 7: Display list of all major component providers with specific reference to location of each component in array. Components included shall include at a minimum: PV module, inverter, mounting systems, DC combiners/disconnects and DAS equipment manufacturers, Display Page 7 for 1 minute.

O. Provide data logging computer, display, and keyboard as described.

P. Mount weather instrumentation with hardware designed for such purpose.

Q. All exposed wiring, including weather instrumentation sensor leads, shall be made with sunlight resistant wire.

R. Signal wire shall be 1.0 mm^2 (18 AWG) min. stranded single pair twisted shielded cable with nonmetallic outer jacket.

S. Thermocouple wire shall be Type T 0.5 mm^2 (20 AWG) min. single pair twisted shielded cable with nonmetallic outer jacket.

T. Provide labeling to DAS conduit runs. This labeling shall identify content of conduit, and shall be visible by maintenance personnel. Labels shall be printed in permanent and durable manner, and in size constant with conductor diameter. Repeat labels as required for continuous identification purposes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive PV system components for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Mounting of PV array:

1. Mounting structure shall be securely fastened to **[roof structure]**, **[roof surface]**, **[covered walkway structure]**, **[covered parking structure]**, **[ground system]**, **[ballast system]**, **[vertical building structure]** as specified in contract.
2. Bolt units directly to mounting structure.
3. Securely fasten combiners, collectors, inverters and system components to building walls, or mount on self-supportive structure located adjacent to array.
4. Mount isolation transformers on 100-mm high concrete housekeeping pad; see Section 033000 “Cast-in-Place Concrete.”

B. String Inverters: Mount PV system inverters in locations approved by Project Director/COR based upon input from OBO/PDCS/DE/EE. Mount as close to DC combiner boxes as possible or PV modules as applicable.

C. Three Phase Central Inverters: For PV systems where total distance of each DC circuit does not exceed 50 meters, mount three phase inverters in locations approved by Project Director/COR based upon input from OBO /PDCS/DE/EE. Mount as close to DC combiner boxes as possible.

D. Power Control Feedback: Mount the power control feedback modules in proximity to inverter location for interaction with all inverters. Identify pathways and provide materials (cabling, current transformers, potential transformers, controllers) to monitor the utility and/or generator systems. Provide interconnection to generators or paralleling switchgear to identify generator operation (loading).

E. Once installed, PV Modules shall be visually uniform and shall be subject to visual inspection for consistency. Replacement of unacceptable PV Modules is responsibility of Contractor.

F. Work of this Section includes work required for PV systems up to, and connection to, each PV system to AC building power distribution system disconnect switches.

G. PV array shall not exceed five PV Modules in at least one direction for maintenance access. PV array shall facilitate maintenance access to all roof drains, antennas, and equipment mounted adjacent to PV array.

H. Safety Requirements:

1. Provide clear and unobstructed access route to PV installations.
2. Installations shall be in accordance with OSHA requirements.
3. Where required provide OSHA approved safety railings at and along access routes to PV systems.

3.3 CONNECTIONS

A. Install equipment grounding conductors for components, with ground continuity to main electrical ground bus of building electrical system to which PV system is connected. See Article on ACCESSORIES regarding restrictions at ground connections.

1. Fine stranded conductors are not permitted for ground connections.

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. Make a permanent mark on all joints, connectors and terminals after they have been torqued to the proper value.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section on identification for electrical systems.

B. PV system signs shall be printed in English and in local language.

C. Appropriately identify and label PV system equipment as required in NFPA 70 with permanent, self-adhesive, engraved red stock with white core plastic with minimum thickness 1.5mm (or approved equal). Lettering shall be standard engravers letter style using standard size appropriate for application in accordance with NFPA 70.

D. Label DC combiners, AC combiner panels, DC-AC inverters, DAS enclosures, and PV system disconnects. Use permanent, self-adhesive, printed labels identifying system component pertaining to PV system, and provided in both English and local language. Lettering shall be standard engravers letter style using standard size appropriate for application in accordance with NFPA 70.

E. Provide warning signs for PV system startup and restart for inverters with DC disconnect switch. Refer to Article on START-UP SERVICES.

F. Provide warning signs for PV system at DC disconnect switches indicating that voltage is present on DC PV Module portion of circuit during daylight hours. Provide warning signs for PV system at AC disconnect switches indicating that voltage is present on local electrical utility portion of circuit when utility power is available.

G. Operating Instructions: Printed basic instructions for PV system components, including operation, disconnection, and emergency procedures.

H. Label DC system components with material described herein for operating DC current (Imax), system operating DC Voltages (Vmax), maximum string DC voltage (Voc), and maximum system DC current (Isc).

3.5 FIELD QUALITY CONTROL

A. Testing: After installing PV System components and after building electrical system has been energized, demonstrate product capability and compliance with requirements.

B. Contractor shall be present for complete system review and startup acceptance test with Project Director/COR and other Government representatives. Contractor shall be prepared at any time during this process to provide access to all portions of installation and shall remedy any portion of system that is not in compliance with this specification within 30 days of noted deficiency, that does not perform to manufacturer's operating specifications, or that fails to operate due to poor workmanship.

C. In addition to the following test sequence, Contractor shall perform all tests required by manufacturer as outlined in inverter's installation and operator's manual.

1. Ensure that inverter is switched off before proceeding.
2. Test and record AC line voltage at the inverter to ensure that it is within proper limits as stated by the manufacturer.
3. Test that phase sequencing is correct, if applicable.
4. Check continuity of all fuses.
5. Check that DC open circuit voltage is within manufacturer's recommended range at DC disconnects.
6. If DC voltage is correct, close inverter cover, close DC and AC disconnect switches, and turn on inverter.
7. After Manufacturer's specified start-up time, confirm that inverter is operating by recording DC operating voltage and currents, AC Phase voltages and phase currents and inverter power.
8. Close all open equipment enclosures.
9. Look and listen for, find the cause of, and remedy anything unusual from the PV array or PV system components.

D. Additional testing shall demonstrate proper functional operation of control and protective features under normal and abnormal conditions. In some cases, devices external to inverters can handle one or more of these features:

1. Confirm wake-up and sleep operations of PV system.
2. Confirm inverter sleep operation during loss of building power and loss of array.
3. Confirm Power feedback controller operation for **[Generator], [Utility]** interface.

E. Provide photo record of installation and major components, including PV Modules, inverters, transformers, combiners, collectors, and all display screens shall be made. Include photos showing connections within all installed enclosures. Provide electronic copies of photo record on compact disc and hard copy of the photo record (with labels for each photo) in Operation and Maintenance Manual identified in Article on SUBMITTALS.

F. [Flood Testing: Prior to installation flood test each deck area for leaks according to recommendations in ASTM 5957. After installation of waterproofing, flood test disturbed areas before overlying construction is placed. Install temporary containment assemblies, plug drains and flood with potable water. Contractor shall continuously monitor testing both interior and exterior to ensure all leaks are immediately identified and repaired. In event of detected leak, stop test immediately.

1. Flood to average depth of 65 mm (2-1/2 inches), with minimum depth of 25 mm (1 inch), and not exceeding depth of 100 mm (4 inches). Maintain 50 mm (2 inches) of clearance from top of sheet flashings.
2. Flood each area for 24 hours.
3. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.

G. Engage independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.]

3.6 PRE-OPERATIONAL APPROVALS

A. For sites served by local electric utility company, do not connect PV system to building electrical power distribution system for testing purposes without Interconnection Agreement from local electric utility company. The Contractor shall coordinate with the local Utility Company and assist the US Government as required by preparing and submitting an Interconnection Application and obtaining a new or amending an existing "Interconnection Agreement" in accordance with the serving Utility Company requirements. Once entire PV system is correctly installed and properly wired, and preliminary field-testing, system review and start-up test are successfully completed, Contractor shall contact utility to schedule and be present for any inspections required for PV system approval. Interconnection Agreement from local electric utility company must be received before system is permanently paralleled with their system. Contractor shall obtain this approval from local electric utility company and include a copy in the Operation and Maintenance Manual.

3.7 CLEANING

A. Remove all excess sealants, fillings, grease, tape residue, dust and debris from PV system components.

B. Protect work from damage by other trades.

C. Ensure site is clean and secure, in workman like condition, during and at completion of the project.

D. [Patch and repair existing walls, roofs, irrigation, asphalt, concrete, hardscape, painting, and other existing construction impacted by the project to match original condition(s).]

3.8 STARTUP SERVICES

A. Perform testing as prescribed in this specification and in accordance with manufacturer's recommendations.

B. For PV system incorporating inverters with ON switch, all PV system disconnects are in CLOSED position prior to turning on inverter. For PV system incorporating inverters that do not incorporate an ON switch, PV system will be turned on when all PV system disconnects are in CLOSED position.

C. Ensure there is interconnection agreement from local utility company for interconnection of PV system with utility grid is obtained prior to startup. Local utility company may require that representative of utility be on-site during initial interconnection; Contractor shall accommodate this requirement, if stated by utility.

D. Startup for the Data Acquisition System (DAS). Perform the following tests before system is deemed complete.

1. Confirm that DAS reads zero for all measurements when respective instruments are turned off.
2. Verify and record that all measurements are reading in proper range when respective instruments are turned on. Include copy of test results in Operation and Maintenance manual described herein.
3. Verify that all files created by DAS are in proper format and have proper values.
4. Verify that real time data is being displayed properly on lobby display.
5. Confirm that all links to real time and archived data are working properly.
6. Confirm that data files are retained upon loss of power.
7. Confirm that daily, monthly, and total since system installation files are being generated properly.
8. Confirm that UPS shuts down computer upon extended power outages.
9. Confirm that data acquisition system starts automatically and re-established network connections upon restoration of power.

3.9 COMMISSIONING

A. Commissioning Agent: Engage electrically qualified commissioning agent to inspect, field test, and document performance of components and equipment after installation. Commissioning agent shall prepare written test results in report. Report shall include documentation of all potential shading obstructions on PV Modules.

B. All test instruments shall be identified in Report and listed by manufacturer, model number, serial number, date of calibration, and calibration authority. All test instruments shall have been calibrated within past year. Test instruments shall have attached calibration sticker that is traceable to NIST.

C. Obtain copy of local utility company's agreement to connect PV system to building power distribution system prior to all testing.

D. Contractor shall obtain written commissioning procedures document. Procedure entries shall include: Date; time; person taking data; recorded value of data; indication if recorded value is out of range of system and/or equipment tolerance. Each page of the procedures must include: test name; equipment tested; location; date; time; person performing test; model number of equipment; serial number of equipment; manufacturer; tolerance ranges of equipment tested for reference. Approach to numbering PV Modules in PV array for testing shall be identified.

E. Witness startup of PV system. Government representative shall witness startup with Commissioning Agent.

F. Commissioning Agent shall keep Commissioning Issues Log and include it as appendix to Report. Log shall include, but not be limited to: issue description; log tracking number; date; time; person investing issue; action taken; person taking action; date of closure of issue. Include copy of Commissioning Issues Log in written procedures to Contractor.

G. Perform the following field tests and inspections as follows for test report:

1. Test insulation resistance and continuity for each DC circuits, AC feeders, grounding including ground fault protection, and control circuits. Disconnect all sensitive electronic equipment prior to testing. Visually and mechanically inspect all cabling, connections, and conduits. Verify color coding of conductors per NFPA 70. Verify proper torque of termination connections with calibrated torque wrench.
2. Test ground fault protection of PV system (where required).
3. Test grounding continuity by measuring array-to-earth ground resistance.
4. Test output and performance of the isolating transformer in accordance with Section 262214 "Low-Voltage Transformers." Set taps as necessary.
5. Test output of each PV String. Identify which panels are shaded at any point of day between 9 AM and 4 PM.
6. Verify proper voltage and current to each input to combiner boxes, inverters, AC collector boxes, and isolation transformer.
7. Ensure string DC open circuit voltage within 5% of each other and within manufacturer tolerances.
8. Verify string maximum powerpoint voltage (Vmp) within 5% of each other and current at maximum powerpoint (Imp) within 5% of each other.
9. With collected data, calculate expected Voc, Vmp, Imp, AC watts, and power performance ratio (what is produced/what is expected).
10. Verify insulation resistance per manufacturer tolerances.
11. Test proper operation of inverters including loss of utility, restoration of utility, generator start, ATS operation, PV system shutdown/restart functions, and PV system efficiency. Set output voltage as necessary. Verify that all local utility notifications and requirements have been incorporated into PV system.
12. Measure open circuit voltage drop on all DC circuits and AC feeders. Verify that voltage drop between PV modules and inverters do not exceed 3 percent on each DC circuit. Verify that voltage drop between inverters and connection to building power distribution system does not exceed 1 percent on each AC feeder.
13. Verify operation of all disconnect switches and proper sizing of all overcurrent protection devices in accordance with Division 26 Sections on enclosed switches and circuit breakers and on panelboards.
14. Witness flood test.
15. Verify that displays accurately represent output of PV system. Independently measure energy produced by PV system, and compare data to log data of DAS. Track data and compare data to log data for minimum of one month.
16. Performance testing: Provide current-voltage (IV) curve tracing for each PV string for complete day using a PV analyzer or equivalent device. This data shall be used to compare to PV string performance with nameplate (STC) conditions. Identify and remedy PV module defects, wiring defects, or connection problems, and identify shading issues.
17. Power feedback controller: Monitor the utility power factor with the PV system functioning and with it disconnected. Identify the observed power factor. Verify the system modulates this power factor to not adversely affect utility billing.
18. Verify that remote data logging access has been established and is functioning. Provide all necessary data, IP addresses, login-ins, and passwords to post.

H. Contractor shall remove and replace malfunctioning equipment. Retest PV system as specified above.

3.10 DEMONSTRATION AND TRAINING

A. Provide 6 hours on-site training session for PV system components and Data Acquisition System (DAS). Provide Instructor with at least five years' experience in installation and operation of PV systems used in project. Session shall review system, including review of wiring diagrams, equipment list, spare parts inventory, system isolation and de-energization procedures for maintenance workers (i.e., lockout/tagout), failure modes and effects analysis by component, and proper maintenance and cleaning procedures (including use of cleaning equipment).

END OF SECTION 263105

SECTION 263214 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies generator sets (gensets) for use as backup electric power sources. Genset consists of:

1. Liquid-cooled compression ignition diesel engine directly connected through flexible coupling to alternating current generator with rotating exciter.
2. Solid-state voltage regulator.
3. AC output circuit breaker.
4. Electronic governor.
5. Cooling system.
6. Air intake system.
7. Exhaust system.
8. Control panel.
9. Remote monitor capability.
10. Remote control capability.
11. Engine starting system.
12. Battery.
13. Battery cables, battery retainer, and engine driven battery charger.
14. Rigid box type channel steel or formed steel base.
15. Dual wall day fuel tank.
16. Integral genset radiator.
17. Auxiliary fuel connection.
18. Vibration Protection
19. Seismic Protection
20. **[Wall-mounted static battery charger with AC input breaker.]**
21. Maintenance spare parts maintenance and repair.
22. Other components necessary to provide complete self-contained genset.

B. Related Sections:

1. Section 230719 "HVAC Piping Insulation" for muffler and exhaust pipe insulation.
2. Section 230905 “Instrumentation and Controls for HVAC” for communications-interface with building automation system (BAS).
3. Section 230548 “Vibration and Seismic Controls for HVAC” for muffler and exhaust piping vibration-isolation supports and hangers.
4. Section 231113 “Facility Fuel-Oil Piping” for interior fuel piping and fuel storage tank.
5. Section 232113 “Hydronic Piping” for coolant piping external to engine generator.
6. Section 233113 “Metal Ducts” for combustion air and radiator fan discharge connections.
7. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety” for facility voltages.
8. Section 260548 “Vibration and Seismic Controls for Electrical Systems.”

9. Section 260553 “Identification for Electrical Systems” for noise hazard signs at engine generator rooms.
10. Section 260573 “Overcurrent Protective Device Coordination Study.”
11. Section 262325 “Power Sequence of Operation.”
12. Section 263600 “Transfer Switches” for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generator sets.
13. Section 335633 “Underground Hydrocarbon Storage” for interface with fuel supply.

1.2 REFERENCES

A. The following publications form a part of this specification to the extent specified herein:

1. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI).

   a. ANSI/IEEE C57.13.1, Guide for Field Testing of Relaying Current Transformers.
   b. ANSI/IEEE 115, Guide for Test Procedures for Synchronous Machines Including Acceptance and Performance Testing and Parameter Determination for Dynamic Analysis.

2. AMERICAN SOCIETY FOR MECHANICAL ENGINEERS (ASME).

   a. ASME Y14.44, Reference Designations for Electrical and Electronic Parts and Equipment.

3. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM).

   a. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. ASTM C356, Standard Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat.
   c. ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
   d. ASTM C665 Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   e. ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
   f. ASTM D523, Standard Test Method for Specular Gloss.
   g. ASTM D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   h. ASTM D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   i. ASTM D3359, Standard Test Methods for Rating Adhesion by Tape Method.
   j. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.

4. INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

   a. IEC 60034, Rotating Electrical Machines.
   b. IEC 60947, Low-Voltage Switchgear and Control gear.

5. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO).

   a. ISO 3046: Reciprocating Internal Combustion Engines – Performance.

      1) Part 1: Declarations of power, fuel, and lubricating oil consumptions, and test methods.
      2) Part 2: Test methods.
      3) Part 3: Test measurements.
      4) Part 4: Speed governing.
      5) Part 5: Torsional vibrations.
      6) Part 6: Overspeed protection.
      7) Part 7: Codes for engine power.

   b. ISO 8528: Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets.

      1) Part 1: Application, ratings, and performance.
      2) Part 2: Engines.
      3) Part 3: Alternating current generators for generator sets.
      4) Part 4: Controlgear and switchgear.
      5) Part 5: Generating sets.
      6) Part 6: Test methods.
      7) Part 7: Technical declarations for specification and design.
      8) Part 8: Requirements and tests for low-power generating sets.
      9) Part 9: Measurement and evaluation of mechanical vibrations.
      10) Part 10: Measurement of airborne noise by the enveloping surface method.
      11) Part 12: Emergency power supply to safety services.

   c. ISO 9001: Quality systems, model for quality assurance in design, development, production, installation, and servicing.

6. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA).

   a. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. NEMA ICS 1, Industrial Controls and Systems.
   c. NEMA MG 1, Standard for Motors and Generators.
   d. NEMA MG 10012, Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.

7. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

   a. NFPA 30, Flammable and Combustible Liquids Code.
   b. The OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).
   c. NFPA 110, Standard for Emergency and Standby Power Systems.

8. SOCIETY OF AUTOMOTIVE ENGINEERS (SAE).

   a. SAE J614, Engine and Transmission Dipstick Marking.

9. UNDERWRITERS LABORATORIES INC (UL).

   a. UL 142, Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
   b. UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.
   c. UL 1008, Transfer Switch Equipment.
   d. UL 2085, Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids.

1.3 DEFINITIONS

A. Accuracy/error: Accuracy is ratio that defines limit of error expressed as percentage of full-scale value. Error is difference between indication and true value of quantity measured. It is quantity that gives true value when algebraically subtracted from indication. Positive error denotes that indication of meter is greater than true value.

B. Biofuels: Fuel that is manufactured from organic sources, equivalent to Biodiesel, Ethanol, and/or Methanol.

C. Damage: Damage is defined as any failure (see definition below) or degradation in life. Blowing (opening) of replaceable fuse is not considered damage, provided it is performing its intended function.

D. Dangerous flexural vibration: Dangerous flexural vibration is defined as vibration that occurs at speed at which maximum stress in shaft from flexural vibration exceeds 630 kg/cm^2 (9,000 psi).

E. Dangerous torsional critical speed: Dangerous torsional critical speed is defined as speed at which maximum vibrating stress in shaft from torsional vibration exceeds 350 kg/cm^2 (5,000 psi).

F. Dripproof enclosures/boxes: Dripproof enclosure/box is enclosure/box so constructed that falling drop of liquid or solid particles striking enclosure/box at angles from 0 to 15 degrees from vertical cannot enter enclosure/box, either directly or by striking and running along horizontal or inwardly inclined surface.

G. Failure: Failure is defined as inability of item to perform within specified limits.

H. Day fuel tank: Day fuel tank is defined as tank that is supplying fuel to engine, equipped with provisions (e.g., float valve, electric pump, solenoid) for receiving fuel from auxiliary source.

I. Deviation factor: Deviation factor of a wave is the ratio of the maximum difference between corresponding ordinates of the wave and of the equivalent sine wave to the maximum ordinate of the equivalent sine wave when waves are superimposed in such a way as to make this maximum difference as small as possible. The equivalent sine wave is defined as hiving the same frequency and the same rms value as the wave being tested.

J. Quick Connect: Hydraulic connection that allows for single hand, non-tool connection and disconnection of hoses; required for hose and connection at generator.

K. Maximum power: Maximum power is defined as largest load that genset can carry for two minutes and remain at rated voltage and frequency without damage.

L. Momentary overload: Momentary overload is defined as loads between rated and load required to trip safety devices.

M. Power exchange: Power exchange is measured difference between maximum and minimum power output delivered by one genset for constant system load.

N. Prime Rated Power (PRP): Prime power is defined (ISO 8528-1) as maximum continuous load capability of genset. Ten percent overload (ISO 3046-7) is available for one hour out of twelve hours.

O. Rated frequency: Rated frequency is specified in Article on PERFORMANCE REQUIREMENTS.

P. Rated kW: Rated kW is rating shown on genset nameplate.

Q. Rated load: Rated load is rated kW at rated power factor, rated frequency, and rated voltage.

R. Rated power factor: Rated power factor (pf) is 0.8 lagging.

S. Rated voltage: Rated voltage is genset name plate voltage.

T. Stable (engine) operating conditions: Stable (engine) operating conditions are conditions specified for short-term, steady-state performance.

U. Start: Genset is considered to have started when it is operating at rated voltage and rated frequency without further use of starting aids.

V. Stop: Genset is considered to have stopped when all rotating members are at zero rpm, except for turbocharger, if used.

W. Temperature and humidity damage: Temperature and humidity damage is defined as conditions causing malfunction of any component or part, corrosion, breakage, deformation, or reduction of insulation resistance below 50,000 ohms.

X. Telephone Influence Factor (TIF): The Telephone Influence Factor (TIF) of a synchronous generator is the measure of the possible effect of harmonics in the generator voltage wave on telephone circuits.

1.4 PERFORMANCE REQUIREMENTS

A. General:

1. Engine/generator set must be rated for **[Prime Power (PRP)][Standby]** operation.
2. Classification: Gensets and all associated components (e.g., fuel pumps) must operate at host country frequency and host country nominal voltage.

3. Voltage Connections: Gensets must be connectable for Site Distribution Voltage.
4. Generator Performance:

   a. Voltage waveform

      1) Deviation factor per NEMA MG 1: Voltage waveform deviation factor must not exceed 10 percent. The frequency must be maintained with +/- one half (0.5) percent of the value required for the test being conducted. Test must be performed where the voltage unbalance does not exceed 1 percent.
      2) Telephone Influence Factor (TIF): TIF must not exceed the values (values vary based on kVA and voltage ratings of generator) listed in NEMA MG 1. TIF must be measured in accordance with IEEE 115 at the generator terminals on open circuit at rated voltage and frequency.

   b. Phase Balance (voltage): With genset under control of exciter and voltage regulator, and operating at rated voltage, frequency, and no load, the maximum unbalanced line-to-neutral voltage must not be more than one-half (0.5) percent of rated line-to-neutral voltage.
   c. Dielectric Strength: Windings must withstand the following 50 or 60 Hz voltages applied for one minute:

      1) Generator Stator: Twice rated line-to-line voltage plus 1000 volts between phase windings, and twice rated line-to-neutral voltage plus 1000 volts between phase windings and ground.
      2) Generator Field and Exciter Windings: 10 times ceiling voltage but neither less than 1,500 nor more than 3,500 volts applied between windings and ground.
      3) Windings Energized by DC Control, Cranking, and Battery Charging Systems: 500 volts applied between windings and ground.
      4) All Others: Twice rated voltage plus 1,000 volts, applied between winding and ground and between windings where applicable.

   d. Voltage Regulation: Voltage regulation must be less than or equal to one half (0.5) percent of rated voltage.
   e. Voltage Stability: At any constant load from no load to 110 percent of rated load, voltage must remain within bandwidth of one percent of rated voltage.
   f. Voltage Drift: With genset operating at constant load and voltage, change in ambient temperature of 15 deg C in eight-hour period must not cause voltage to change more than one percent of rated voltage. Genset must be stabilized at both initial and final ambient condition.
   g. Voltage Transient Performance: With genset operating at rated frequency and voltage, transient voltage response must remain within transient voltage operating limit values listed in ISO 8528-5.

5. Voltage Operating Range: Voltage adjusting device must be capable of adjusting voltage to +/- 5 percent of rated voltage with genset operating at any load up to 110 percent rated load.

6. Short Circuit: Generator and/or excitation system must not be mechanically and/or electrically damaged when temperature is stabilized at rated load and then subjected to faults at genset load terminals that draw 300 percent rated current for 10 seconds.

7. Generator and Excitation System: Genset voltage performance must conform to performance class **[G2][G3]** of ISO 8528.
8. Starting and Operating: Genset must start (see Article on DEFINITIONS) within 10 seconds after receiving start signal under each and any combination of the following operating conditions. Immediately after starting, genset must operate without degradation or shutdown at all loads, continuous and intermittent, up to and including rated load as specified herein.

    a. At all possible relative humidity levels with ambient temperatures in the paragraph on "Service Conditions," with engine coolant at higher than + 20 deg C.
    b. At altitude specified in paragraph on "Service Conditions."

9. Starting Selection: Where multiple Gensets are installed as a system, starting sequence must be programmable for selecting individual generators for startup and transfer. If selected primary generator fails to start, secondary generator must start to close load.
10. Stopping: Genset must stop (see Article on DEFINITIONS) within 30 seconds after activation of any device intended to stop set.
11. Cool Down Period: Generators must start and come online automatically on loss of normal power. Generator must run for at least 5 minutes to cool down before generators are shut down automatically on restoration of normal power and after load has been transferred to normal power.
12. Paralleling of multiple generator systems must not be through generator onboard control without prior written approval from OBO/PDCS/DE/EE. Generator breaker is intended for servicing and protection only, not for control. No powered closers are permitted on generator mounted breaker.
13. Open Transition: When used, Automatic Transfer Switch (ATS) must allow for open transition when utility power is restored with time delay appropriate to clear onsite electric fields.
14. Operating Speeds: Operating speed for 50 Hz gensets must be 1500 revolutions per minute (rpm). Operating speed for 60 Hz gensets must be 1800 revolutions per minute (rpm).

    a. Protection: Per NEMA MG 1, generator sets must be designed to prevent damage from overspeed and torsional vibrations. Per NFPA 110, a certification must be supplied with the unit that verifies the torsional vibration compatibility of the rotating element of the prime mover and generator for the intended use of the energy converter.

15. Sound Pressure Levels: Genset sound pressure level (SPL) at 7 meters (23 feet) from surface of genset and 1.2 meters (4 feet) above genset base must not exceed average "A" weighted sound pressure level as follows:

    a. Style I (Unhoused gensets): **[90]** dBA

16. Radio Frequency Interferences: Radio interference emissions must comply with IEC 60034 when genset is operating at any load from no load to rated load.

17. Fuel: Engine must start, operate, and meet all performance requirements of this specification using commercial #2 diesel **[high-sulfur]**fuel.
18. Life (Endurance) requirements: Genset must have life expectancy of 10,000 hours at loads up to and including rated load under ambient conditions specified herein when maintained in accordance with manufacturer's instructions.
19. Ease of Servicing, Operation, and Maintenance: Design and construction of gensets must permit routine service and maintenance under field conditions. Parts that require adjustment or servicing must be capable of being adjusted or serviced by personnel wearing heavy winter clothing or mittens. Genset must be capable of being started and operated by one operator under all conditions. Starting or stopping set must not require manipulation of more than one control or switch. Hardware that requires torquing must be able to be installed and services so that nut, bolt, or screwhead is accessible for torque wrench application. In assemblies where both bolt and nut are used, nut must be accessible for torque wrench application. Genset maintenance and repair must be accomplished with common standard tools. Servicing, operation, and maintenance requirements must be capable of being met with genset in its installed location. General maintenance schedules for prime-rated equipment that will not be operated as prime generation must not require rebuilds on less than 8000-hour overhaul schedule.

B. Service Conditions:

1. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

   a. Ambient temperature: Refer to Schedule on Drawings.
   b. Altitude: Refer to Schedule on Drawings.
   c. External Static Pressure: Refer to Schedule on Drawings.

2. **[Unusual Service Condition: Engine generator equipment and installation must operate under high salt/dust content in the air due to [corrosive environment (e.g., location near salt water)][and][dusty environment requiring pressure cutout sensors for clogged airflow].]**

1.5 SUBMITTALS

A. Product data for system components. Include descriptive and technical literature, catalog cuts, and installation instructions. Provide dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and UL listed data.

1. **[Emissions requirements. Xxx.]**
2. Installation manual. Include the following:

   a. Genset noise levels at various distances from genset.
   b. Allowable engine exhaust restriction if using exhaust extension.

c. Allowable genset cooling air discharge restriction if cooling air is ducted away from genset.
d. Fuel pump head pressure.
e. Instructions for installation of all equipment, non-integral components, and accessories.
f. Instructions for aligning genset before initial startup and after disassembly.

B. Shop drawings must indicate fabrication details, dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Locate and identify each interface point (e.g., lube drain, exhaust outlet, fuel inlet), grounding terminal, and similar items.
2. Indicate proper genset location such as allowable ground slope, clearance required for door opening, and clearance required for engine exhaust.
3. Wiring Diagrams: Detail wiring for power and control connections and differentiate between factory-installed and field-installed wiring.
4. Vibration Isolation Base Details.

C. Design calculations. **[Xxx xxx.]**

D. Qualification data for firms and persons specified in Article on QUALITY ASSURANCE.

1. Support Services Vendor: Identify vendor firm name and contact, location, distance from project, and years servicing product line.

E. Factory Test Plans and Reports: For units to be shipped for this Project, provide evidence of compliance with specified requirements.

1. Test plans submitted for review at least 3 weeks prior to testing.
2. Test reports indicating completion and compliance with testing requirements in this specification.

F. Field Test and Observation Reports: Indicate and interpret test results and inspection records relative to compliance with performance requirements.

G. Maintenance Data: For each genset, provide manufacturer's Operations and Maintenance manual.

1.6 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain generator components from single source which assumes responsibility for compatibility of system components.

B. Support Service Capability: Genset manufacturer's representative to start-up generator, and representative must have current active certification by manufacturer.

C. Operations and Maintenance Support Services: Genset dealer authorized representative or manufacturer-approved support services representative must be available to provide ongoing maintenance services at project site within 24 hours.

D. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

E. Inspection:

1. Inspection system: Gensets, generators, and engines must be manufactured in facility that has certified quality control program such as ISO 9001.
2. Responsibility for Inspection: Unless otherwise specified, Contractor is responsible for performance of all inspection/test requirements as specified herein. Except as otherwise specified herein or elsewhere in Contract, Contractor may use their own facilities or any other facilities suitable for performance of inspection/test requirements specified herein, unless disapproved by Project Director/COR based upon input from OBO/PDCS/DE/EE. Contractor is responsible for ensuring that all components and materials used are manufactured, examined, and inspected/tested in accordance with industry standard practices.
3. Verification: Government reserves the right to perform or repeat any of inspections/tests set forth in this purchase description where such inspections/tests are deemed necessary to ensure supplies and services conform to prescribed requirements.

1.7 DELIVERY, STORAGE AND HANDLING

A. Shipping and Handling: Enclose each genset on shipping skid and take precautionary measures to protect from inclement weather and damage during transit. Equip genset skid base with towing and lifting provisions for lifting and/or towing of genset without damage using forklift, crane, or hoist. Deliver engine generator set and system components to final location in protective wrappings, containers, and other protection that will exclude dirt and moisture and will prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

B. Connection Tag: As safety precaution, the alternator must have a permanently affixed electrical output data tag.

1.8 MAINTENANCE PARTS

A. General parts: Provide one set of maintenance (spare) parts for each genset. An order of maintenance parts is defined as follows:

1. Engine lubricating oil filters (and filter gaskets if separate from filter).

2. Fuel filters (and filter gaskets if separate from filter).
3. Engine intake air filters (and filter gaskets if separate from filter).
4. A minimum of five electrical fuses of each size fuse used in the genset.
5. One belt set.

PART 2 - PRODUCTS

2.1 GENERATOR SET

A. Generator: AC generator must be synchronous, revolving field, brushless, air-cooled, self-ventilated alternator that is directly connected to engine crankshaft through flexible steel coupling. Generator must be capable of operation at **[50][60]** Hertz, must have legibly identified power leads, and must be connectable for the site distribution voltages as well as **[120/208][277/480][other voltages as directed by OBO/PCS/DE/EE]** volts. Generator must conform to applicable requirements of NEMA MG l. Generator windings must be copper and wound with 2/3 pitch. Generator must have Class H insulation system rated at 105 deg C temperature rise above 40 deg C ambient when operating at prime rated load, and generator must have amortisseur windings to minimize slot harmonics. Generator windings must have protective overcoat for added protection in harsh conditions. Generator must have drip-proof enclosure with ventilating openings covered by removable screens having mesh opening not larger than 13 mm. Rotor assembly and fan assembly must be balanced separately, and balanced in accordance with NEMA MG l. When operating at rated speed and voltage, and at any load from no load to rated load, vibration amplitude (peak-to-peak) must not exceed value as specified in NEMA MG l for rated speed of generator. Vibration amplitude in all three axes (vertical, longitudinal, and transverse) at bearing housing or on generator frame adjacent to bearing housing must comply with NEMA MG 1.

B. Materials and Components: Materials and components required, but not specifically specified must be selected by Contractor, must be subject to all requirements of this specification, and must conform to accepted industry standards.

1. Hoses and hose fittings: Use hoses and hose fittings with piping systems where there is relative motion between parts. Hoses and fittings must be suitable for pressure involved.
2. Hardware: Hardware must be as follows, with number of different sizes and types kept to minimum. All nuts, bolts and screws must have standard metric or SAE threads.
3. Pipe and fittings: Conform to SAE standards.
4. Instrument transformers: Current and potential transformers used for instrumentation and relaying must be in accordance with ANSI C57.13.1, and suitable for operation on **[50] [60]** Hz. Transformers must be 1.2 kV insulation class or higher. Instrument transformers must be within limits specified for 0.6 accuracy class. Burden rating of all transformers must be compatible with application requirements.
5. Shunts: Shunts for instrumentation purposes must have industry standard outputs.
6. Terminal lugs: Use terminal lugs for all conductors. Terminal lugs must be insulated, ring tongue style, compression, or crimp type lugs. Install compression lugs with proper tools. Terminal lugs must be proper size for conductor and stud/bolt.

7. Pushbuttons and limit switches: Limit switches must be of sealed type. Pushbuttons must be of sealed heavy-duty type. Pushbuttons and limit switches must be appropriately sized for both voltage and current.
8. Relays: Relays must be totally enclosed or hermetically sealed. Control relays must be firmly secured to their mounting using clips, spring retainers or screws.
9. Hinges and latches: Hinges must be of stainless steel. Hinges or hinge pins must be peened at ends, or other means provided to prevent workout of pins. Latches must require manual, not spring, action for closing. Parts of latches having relative motion with each other must be corrosion-resistant metal.
10. Drivebelts: Drivebelts must be resistant to battery electrolyte, antifreeze, and petroleum derivatives.

2.2 ENGINE

A. Engine: Engine must be heavy-duty standard commercial industrial diesel-fueled, liquid-cooled engine with sufficient power to drive generator and connected accessories and to accept one-step application of rated load.

2.3 GOVERNOR

A. Governing: Engine speed must be controlled by isochronous load sensing electronic governor. Genset frequency performance must conform to performance class **[G2][G3]** of ISO 8528.

1. Frequency regulation: Frequency regulation must be adjustable from 0 to three percent of rated frequency.
2. Frequency stability: At any constant load from no load to 110 percent of rated load, frequency must remain bandwidth of 1/2 percent of rated frequency.
3. Frequency drift: With genset operating at constant load and voltage, change in ambient temperature of 15 deg C in eight-hour period must not cause frequency to change more than one percent of rated frequency. Genset stabilization must be accomplished at both initial and final ambient condition.
4. Frequency adjustment range: Frequency adjustment device must be capable of adjusting frequency to plus/minus 5 percent of rated frequency.

2.4 ENGINE COOLING SYSTEM

A. Cooling System: Cooling system must have capacity to limit maximum coolant temperature from engine to value recommended by engine manufacturer while genset is operating under any of environmental conditions specified herein for "Starting and Operating." Engine must have block drain(s) as necessary to completely drain all coolant from block regardless of type of cooling system.

1. **[Genset room conditioning: Genset room must be climate controlled to maintain humidity level at or below 60 percent.]**

2. Integral radiator: Integral radiator cooling system must consist of liquid coolant to air heat exchanger (radiator) with expansion tank and pressure cap, pusher type engine driven fan, engine thermostat, engine driven coolant pump, internal engine coolant passages, and coolant hoses. Interconnect these components to provide completely closed and pressurized system. Genset radiators must have flange adequate for attaching a discharge airduct. Radiator coils/fins must be **[aluminum/aluminum.][copper/copper coils with Heresite P-413 baked phenolic epoxy or approved equal epoxy coating. Use of this coating must not reduce performance by more than 1 percent as specified in Article on PERFORMANCE REQUIREMENTS, paragraph on "Starting and Operating."]**
3. Coolant: Cooling system must operate under all conditions specified in Article on PERFORMANCE REQUIREMENTS, paragraph on "Starting and Operating" using factory-recommended commercial antifreeze and water mixture for the site-specific location, which includes engine-compatible corrosion preventive additives and water mixture.
4. Coolant jacket heater: Equip engine with thermostatically controlled electric immersion heater(s) in engine coolant. Heater system must be capable of maintaining minimum temperature of 32 deg C under all conditions specified in Article on PERFORMANCE REQUIREMENTS, paragraph on "Starting and Operating."

2.5 FUEL SUPPLY SYSTEM

A. General: Fuel system, including piping, valves, filters, and connections must prevent air from entering the system, and must prevent fuel flow from being restricted during operation under all conditions in this specification. Provide permanently installed fuel pump capable of priming the engine fuel system after air has been allowed to enter fuel system. Provide equipment and monitoring system that interfaces with installed facility fuel oil system; see 231113 "Facility Fuel-Oil Piping."

B. Dual Wall Day Fuel Tank: Dual wall day fuel tank must be Underwriters Laboratory (UL) **[142][2085]** listed, complying with NFPA 30 for this application, and must be stand-alone tank**[, unless indicated on project-specific basis by OBO/PDCS/DE/EE to be generator-base mounted]**. Provide the following features:

1. Capacity: Size for eight hours minimum of uninterrupted generator operation at 100 percent of rated power output of engine without being refilled.
2. Construction: Factory-fabricated tank constructed of steel and treated to prevent corrosion both internal and external. Tank construction must be such that finished tank will not leak or be damaged when hydrostatically tested to 35 kPa. Elevate tank not less than 100 mm above floor.
3. Containment: Provide double-walled tank with space between walls serving as secondary containment tank.
4. Locate hot fuel return such that hot fuel cannot immediately be picked up by fuel pickup tube. Install inlet of fuel pickup not less than 13 mm from bottom of tank and cut off inlet end of fuel pickup at angle or vee. Equip generator fuel suction pipe inside day fuel tank with check valve to prevent loss of prime.
5. Connections: Provide fuel supply and fuel return fittings for connection to engine fuel system. Provide 50 mm manual fill, with lockable fuel fill cap and fill tube, overflow port,

required vent openings with caps, lockable drain valves to permit complete drainage of fuel from primary tank and secondary containment, and openings for leak and level monitoring probes.

6. Monitoring and Controls: Day fuel tank monitoring and controls must be compatible with fuel pump controls and leak/load monitoring systems.

   a. Install level control probe in top of tank to monitor fuel oil level and to communicate with pump controller to control supply pump operation.
   b. Provide leak sensor located in annular space between primary and secondary tank, and interface with engine control and monitoring system to provide visual and audible signal when leak is detected.
   c. Configure Low-Level, Critical-Low, High-Level, and Day Fuel Tank Leak alarms so they are transmitted to electronic control panel via dry-contact alarms for facility fuel oil system; coordinate with Section 335633 "Underground Hydrocarbon Storage."

7. Fuel piping and electrical conduit are not permitted to be placed in the same trench.

C. Electric Duplex Fuel Transfer Pump Set Controls: Coordinate with requirements in Division 23 Section on building fuel oil piping for submersible pumps at underground storage tanks as identified in Section 335633 "Underground Hydrocarbon Storage." Fuel transfer system must maintain fuel level in day fuel tank between 80 percent and 95 percent of tank capacity. Operate duplex pumps in lead-lag configuration, with automatic changeover to lag pump if lead pump fails. Pump must be capable of continuous dry operation or provision made to permit user connection of external control to prevent pump from dry operation. Connect pump through fuel level controller and normally closed solenoid valve to terminals for auxiliary control, and then to terminals accessible for user connection to generator room power panel which is fed from ATS or essential bus.

D. Electric Auxiliary Fuel Return Pump: Where there is not gravity fed return, provide auxiliary pump capable of returning excess fuel to remote underground fuel storage tank to prevent fuel oil from overflowing from day fuel tank via vent pipes. Pump must operate automatically when day fuel tank fuel level exceeds high level alarm and must operate manually via switch.

E. Auxiliary Fuel Connection: Provide standard metric or SAE threaded fitting for connection of auxiliary fuel line between sub-base tank or stand-alone day fuel tank and external fuel source. Locate fitting to permit auxiliary fuel line to be connected or disconnected without affecting operation of genset. Provide hand-operated manual fuel transfer pump that allows day fuel tank to be filled in event of failure of primary electrical pump. Where necessary, provide 8-meters (25-foot) auxiliary fuel line; this fuel line must have fitting on each end to mate with genset auxiliary fuel connection.

F. Generator Fuel Oil Supply Line Filters/Water Separator: Fuel filtering system must have sufficient filtration capacity to allow for continuous genset operation on fuel containing up to 15 milligrams of fine test dust per liter of fuel for a minimum of 300 hours. Permanently mark inlet and outlet connection for fuel filter, water separator, and fuel strainer (if used) assemblies. Water separator must not be damaged by freezing of any water that is accumulated therein.

G. Fuel Lines: Protect fuel lines projecting through metal apertures by grommets and secured to framing members. Use cushioned clips, braces, or brackets to securely fasten all piping between tank and engine. All high-pressure fuel lines must be made of black steel pipe. Hose conforming to metric or SAE standards may be used for low-pressure fuel lines, except hose within 250 mm distance to engine exhaust system must have metal shield.

2.6 ENGINE EXHAUST SYSTEM

A. Exhaust System: Engine exhaust system must consist of hospital-grade muffler(s), black steel engine exhaust pipe, wall/roof ventilated thimble with rainguard, and discharge flapper cap to discharge exhaust gas to outside atmosphere.

1. Flexible sections and expansion joints: Provide a flexible section at each engine and an expansion joint at each muffler. Provide flexible sections and expansion joints that have flanged connections. Provide flexible sections made of convoluted seamless tube without joints or packing. Provide bellows type expansion joints. Provide stainless steel expansion and flexible elements suitable for engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Provide expansion and flexible elements that are capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2. Exhaust muffler/silencer: Provide hospital grade muffler/silencer for each engine to reduce exhaust noise. Inlet and outlet connections must be flanged. Provide eyebolts, lugs, flanges, or other items as necessary for support in the location and position indicated. Do not exceed the engine manufacturer's recommended pressure drop. For marine environments, provide standard aluminized steel or 304 stainless steel construction with bottom or side inlet and end discharge flanged connections. Outside mufflers/silencers must be zinc coated or painted with high temperature 204 degrees C (400 degrees F) resisting paint. Provide muffler/silencer with a drain valve, nipple, and cap at the low point of the muffler/silencer.
3. Exhaust piping: Slope horizontal sections of exhaust piping downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction must be long radius. Insulate exhaust piping, mufflers and silencers installed inside any building in accordance with Article on ENGINE EXHAUST SYSTEM INSULATION and covered to protect personnel. Provide vertical exhaust piping with a hinged, gravity-operated, self-closing, rain cover.

4. Wall/Roof Ventilated Thimble: UL listed device. Thimble must be constructed of steel plate sized to match engine exhaust pipe diameter and suitable for use as roof or wall type as indicated on drawings. Provide high-temperature rated sealant RTV 100 Series conforming to MIL-A-46106 for caulking ventilated thimble endplate and at rain hood discharge as per manufacturer requirement.
5. Backpressure: Exhaust system must be such that genset will operate at rated load without exceeding manufacturer's allowable backpressure.

2.7 EMISSIONS

A. **[Submit certification from engine manufacturer stating that engine exhaust emissions must meet xxx.]**

2.8 ENGINE EXHAUST SYSTEM INSULATION

A. Provide removable, hi-temperature rated insulated blanket suitable for 600 degrees C operation, minimum 25-mm insulation thickness, to cover the entire engine exhaust system from the generator discharge to the security plates at the ventilated wall/roof thimble. Vertical engine exhaust piping within building must also be insulated up to the security plates at the roof ventilated thimble.

B. Insulation must meet the following criteria:

1. Corrosive Resistance: ASTM C665 and ASTM C795.
2. Shrinkage: ASTM C356 Linear Shrinkage 1.49% @ 600°C.
3. Dimensional Stability: ASTM C356 Linear Shrinkage 1.49% @ 650°C.
4. Moisture Sorption: 0.01% per ASTM C1104.
5. Thermal Resistance: ASTM C518 (C177) RSI value/25.4mm @ 24°C 0.74 m^2K/W.
6. Density: ASTM C 612 - Nominal 128 kg/m^3.
7. Fire Smoke Rating: ASTM E136 Behavior of Materials @ 750°C Non-Combustible, and ASTM E84 (UL 723) Surface Burning Characteristics Flame Spread and Smoke Developed (PASSED)
8. Maximum Surface Temperature: ASTM C411 Hot Surface Performance in Compliance with ASTM C612 @ 650°C.

C. Outer Jacket: 481-g gray or blue Teflon coated thermal cloth.

D. Inner Jacket: 566-g vermiculite coated thermal cloth.

E. Construction Connector: 10-ply 304 stainless steel thread.

F. Attachments: High-temp Velcro strips and belts with stainless steel double D-Rings.

2.9 COMBUSTION AIR INTAKE SYSTEM

A. Combustion Intake Air System: Air intake must include heavy-duty dry-type air cleaner with disposable barrier-filter elements. Equip air cleaner with air cleaner restriction indicator. Locate restriction indicator so that it can be readily observed. **[Include precleaner.]**

2.10 STARTING SYSTEM

A. General: System must consist of cranking motor, batteries, battery charging system, battery retainer, battery cables and other components required to make complete system.

B. Batteries: Genset batteries must be commercially available dry-charged, lead acid batteries with amp-hour rating, reserve capacity, and cold cranking amps necessary to permit fulfillment of all requirements of this Section. Install insulated boots over battery terminals. Batteries must have total cranking capacity to satisfy NFPA 110.

C. Battery cable: Battery cable must be flexible, low temperature, and oil and acid resistant. Positive cable must have non-conductive red sleeve at both ends. Provide battery terminal connectors on one end of each cable.

D. Battery Retainer: Provide means to retain battery within genset during all transportation and handling; it must be of type that permits easy removal of battery. Provide means to allow drainage of spilled electrolyte out of genset without contact with any set component except retainer. Retainer must be resistant to battery electrolyte.

E. Polarity Reversal: Genset must not be damaged (see Article on DEFINITIONS) in any manner in event polarity of battery cables is reversed. It must not be possible to crank genset with battery polarity reversed.

F. Battery Charging System (Engine Mounted): Provide engine mounted solid-state battery charging system with temperature-compensating characteristics compatible with battery specified herein. Battery charging system must not be damaged by continuous application of short or open circuit to its output. Battery charging system must be capable of maintaining batteries after starting cycle stated in subparagraph above on "Batteries" in state of full charge after four hours of operation in addition to providing required control power.

2.11 LUBRICATION SYSTEM

A. Lubrication System: Set must have positive displacement gear-driven lubrication pump and full-flow oil filtration system that meets all requirements herein using lubricants specified in Article on PERFORMANCE REQUIREMENTS. Oil-level dipstick must be double-marked to accurately indicate full and low oil-level. Place dipstick in readily accessible location.

2.12 CONTROL AND MONITORING

A. Genset Control Panel: For each genset, provide one genset digital control panel that is located on or within very close proximity to the associated genset. Genset control panel must be on face of control enclosure. Panel to provide access to control components in enclosure. Locate control panel to be readily accessible on the generator, within 1.8 meter of floor. Control panels must contain the following:

1. Automatic remote start capability.
2. “Run-Off-Automatic” switch function.
3. Shutdowns as required by NFPA 110.
4. Alarms as required by NFPA 110.
5. Controls as required by NFPA 110.
6. Load shed controls for Level 1 systems (if applicable) as required by NFPA 110.

B. Meters, Switches, and Gauges: Meters, switches, and gauges must include but are not limited to items specified in the following paragraphs.

1. AC voltmeter(s) for each phase or a phase selector switch.
2. AC ammeter(s) for each phase or a phase selector switch.
3. Frequency meter.
4. Voltage-adjusting feature to allow +/- 5 percent voltage adjustment.
5. AC Kilowatt or kVA Meter: Indicate power output of 3-phase, 4-wire genset to accuracy of three percent of full-scale value under the following conditions:

   a. Balanced load at any power factor from unity to 0.80 lagging.
   b. Unbalanced load where three phase voltages, currents, and power factor differ.
   c. With output of any one phase equal to zero.

6. Oil Pressure Gauge: Oil pressure gauge to indicate engine lubricating oil pressure (wired to sensor unit located on engine).
7. Coolant temperature gauge: Coolant temperature gauge to indicate engine coolant temperature (wired to sensor unit located on engine).
8. Running time meter: Running time meter to show only operating hours that genset is producing voltage. Meter must be capable of indicating up and including 9999.9 hours.
9. DC voltmeter: DC voltmeter to indicate battery voltage when RUN-OFF-AUTO switch is in any position except "OFF."

C. Genset Controls:

1. Voltage Adjustment Control: To allow genset output voltage to be adjusted plus/minus 5 percent of nameplate voltage.
2. Frequency Adjustment Control: To allow genset frequency to be adjusted plus/minus 5 percent of nameplate frequency.
3. Monitor Lamp Test Switch: Lamp test switch must be momentary contact switch and connected to illuminate all monitor lights when switch is in the "ON" position.
4. Communications-Interface: Each generator must be provided with Communication-Interface for monitoring by the Building Automation System (BAS); see Specification Section 230905 “Instrumentation and Controls for HVAC.”

   a. Connect Communications-Interface to the BAS via BACNET/IP protocol.
   b. At minimum, Communications-Interface must provide the following generator status parameters to the BAS: Fuel consumption rate, Total Fuel engine has burned, Engine Speed, Engine operating hours, Atmospheric pressure, Battery Voltage, Fuel filter differential pressure, High Exhaust Temperature, Fuel Filter plugged, Low Oil Pressure, and Low Battery Voltage.
   c. Generator manufacturer/vendor is responsible for coordinating this requirement with the BAS contractor to ensure proper interfacing.
   d. Generator manufacturer/vendor must provide all required on-site technical support to demonstrate proper transfer of information between generators and the BAS.

D. Remote Annunciator Panel(s): Provide wall-mounted enclosure(s) for remote annunciators. At Contractor’s option, and as wall space is available, Contractor may consolidate remote

annunciators within each of the panel locations identified below on one or more panel, except as identified in other contract attachments. Each remote annunciator panel must meet requirements of NFPA 110.

1. Panel Locations: If each genset not fully monitored by the Electrical Power Monitoring System, locate a second panel with equivalent functionality in Facility Management (FM) suite in the same room where BAS front end equipment is located. Use dry contacts to send alarm to Post 1 (entire panel functionality not required at Post 1).

    a. Refer to other contract attachments for additional requirements.
    b. Special modifications may be necessary for satisfactory operation if Post gensets are located greater than 250 meters (800 feet) from these panels.

E. Remote Control Panel(s): For ATS controlled Generators only, when required, provide wall-mounted, minimum NEMA 12 enclosure for remote control panel. Location as indicated on Construction Drawings.

1. Panel Features: Each remote control panel must include:

    a. Generator and ATS position labeling
    b. Visual Indications: Indicator lights must indicate position of associated automatic transfer switch as identified below:

        1) “Running”
        2) “Alarm”
        3) “Normal”
        4) “Generator”

    c. Audible alarm indications for alarm indication.
    d. Control toggle for:

        1) Transfer Control

            a) Normal/Auto
            b) Local

        2) Local Generator Control

            a) Off
            b) Run

        3) Local ATS Position Control

            a) Normal
            b) Generator

    e. Lamp test and alarm silence provisions.
    f. Voltage meters:

1) Normal
2) Generator

F. Automatic Transfer Switch (ATS) Interface: Genset must have provisions for acceptance of transfer switch start signal.

2.13 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Control Power Protection: Protect AC and DC control power wiring and components by circuit breaker(s) or fuse(s).

B. Circuit Breaker: Equip genset with heavy duty molded case thermal-magnetic or electronic circuit breaker. Circuit breaker must be UL listed (or IEC rated if 50 Hz) for this application. This breaker must be rated to continuously carry 125 percent of rated current of genset. Thermal trip elements must be set to trip at 130 percent of rated current in not less than 10 seconds or more than 15 seconds. Magnetic trip elements must trip instantaneously when current in any phase exceeds 425 percent rated current. Breaker must be of trip-free design, and trip mechanism must open all phases simultaneously.

2.14 GENERATOR EXCITER AND VOLTAGE REGULATOR

A. Excitation system:

1. Exciter: Generator exciter must be rotating brushless type with rectifier assembly integral with main generator rotor. Mount rotating rectifier assemblies in manner to provide ready access for inspection and replacement of rectifier diodes.
2. Voltage regulator: Voltage regulator must be RMS sensing, 3 phase sensing solid state, and must automatically control output voltage of genset thru action on exciter field.
3. Exciter field power source: Provide power for exciter field by permanent magnet generator (PMG) integrally mounted as part of generator and exciter assembly. PMG and its controls must be capable of sustaining and regulating current supplied to any combination of single or three phase faults at 300 percent of rated current for not more than 10 seconds.

2.15 ACCESSORIES

A. Electrical Interfaces: Provide terminal strip(s), and properly identify for connection to external devices as identified below. These terminals must be readily accessible through genset control housing door(s).

1. Fuel level signal (i.e., low fuel, high fuel, rupture basin leak) from external day fuel tank.
2. Coolant jacket heater power supply.
3. Power strips for battery chargers if not wall mounted.
4. Remote emergency stop capability that overrides all other controls immediately (no intentional delay) to provide stop signal.

B. Wall Mounted Battery Charger: Provide wall-mounted, solid state battery charger. Mount charger in corrosion-resistant ventilated steel enclosure to prevent any contact with electrically energized components. This battery charger must be temperature-compensated constant-voltage type, rated to match battery voltage of genset with over current control to limit output current to 10 amps even when connected to dead battery. Provide conduit knockouts for AC input and DC output. Provide input AC circuit breaker, and indicating light to show that AC power is available. Provide ammeter on DC, connected to show charging current. Provide ground terminal electrically connected to enclosure. Wire charger to accept input AC voltage; it must be frequency compliant with line-to-neutral output voltage from generator room power panel which is fed from ATS or essential bus.

C. Skid Base: Mount and carefully align all rotating equipment of each set, including diesel-engine coupling and generator, on rigid structural steel or formed steel base capable of supporting all components, and permitting handling and lifting into position without affecting alignment of equipment. Check alignment if necessary of two-bearing generator. Provide split-bolt type grounding terminal permanently attached near load cable entrance provision and electrically bonded to skid base.

D. Vibration/Seismic Isolators: Provide **[normal spring type vibration isolators in areas with low seismicity][seismic-type isolators for areas that do not have low seismicity]** according to applicable site seismic requirements between genset skid and foundation. Where sub-base day fuel tank is used, use only one set of isolators between skid and tank, or between tank and foundation. Spring isolators must reduce transmitted vibration from genset to foundation to maximum 40 microns total amplitude throughout frequency ranges down to 66 cps during all phases of set operation.

E. Dampers: Generator dampers must be spring-actuated open and electrically closed; and control signal must also come from generator itself rather than third party BAS.

2.16 FABRICATION

A. Corrosion-Resisting Metals and Treatments: Fabricate gensets from compatible metals and materials that are inherently corrosion resistant or treated to be resistant to various forms of corrosion and deterioration that may be encountered in storage and operating environments for the project.

B. Treatment and Painting: Genset housing and external components shall be painted to manufacturers standard specifications using procedures that result in coating that meets the following: Salt Spray in accordance with ASTM B117, 1000 + hours.

C. Dissimilar Metals: Do not use dissimilar metals in intimate contact with each other unless protected against galvanic corrosion.

D. Wiring: All wire must be secured neatly into harnesses. Wires in all harnesses must be of proper length and must be so run and secured (with insulated clamps) to protect insulation against contact with sharp corners and edges, pinching, sharp bending and twisting, abrasion because of vibration or contact with moving parts, and exposure to engine fuel oil, lubricating oil, and parts at high

temperatures. Conductors must not be clamped to or supported by fuel or oil lines. Where cable or wire is run between parts that move relative to each other (from vibration, adjustment, inspection, or as matter of normal operation), leave sufficient slack in harness to allow repeated movement to take place without bending or twisting to point of damaging wire in any manner. Splicing of wires is prohibited. Terminate wiring harnesses in connectors or terminal lugs at each end or branch, except solder connections may be made to potentiometers, resistors, semiconductors, fuseholders, capacitors, and press-to-test indicator lights. Provide means to prevent liquids from contacting any electrical connection for all operating conditions specified herein. Do not attach more than two terminal lugs with any one screw on screw type terminal boards and attach no more than four terminal lugs to any one stud on stud-type terminal boards. Terminals on electrical components must not have more than one wire attached.

E. Soldering: Soldering must be in accordance with standard commercial practice.

F. Safety: Exposed moving parts, parts that have exposed high operating temperatures, parts which may be electrically energized, and parts that are hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices in such a manner that proper operation of equipment is not impaired, and in accordance with NEMA MG 10012 requirements.

2.17 SOURCE QUALITY CONTROL

A. Tests (Gensets): All witness testing of the gensets must be accomplished using coolant, fuel, and lubricating oil as specified herein. Where paralleling switchgear is used, there must be system witness test at the factory. Where switchgear and generators are manufactured and tested by two different companies, arrangements must be made for system factory witness test. Witness testing must be attended by Department of State participant from OBO/PDCS/DE Electrical Engineer; notify OBO/PDCS/DE/EE through Project Director/COR a minimum of three weeks in advance of witness testing.

B. Production Genset Tests: Production generator test must include dielectric strength (high pot) test. Generator test results must be identified with applicable generator model and serial number, and ship results with generator to genset assembler for inclusion with genset test results that are shipped with genset. Test each genset before delivery; identify test results with applicable genset model and serial number and be ship results with genset. Production tests must include the following as a minimum:

1. Start and Stop tests (local control).
2. Start and Stop tests (remote control).
3. For standby units, operate at rated load for three hours minimum. For Prime Rated Power units, operate at rated load for two hours minimum followed by test at 110 percent of rated load for one hour. Note amount of fuel used during timed test(s).
4. Application and dropping of rated load in one step (minimum of 5 times).
5. Proper operation of all indicators and controls.
6. Simulate each abnormal condition associated with each protective device to verify proper operation of shutdown protective system wiring.

7. Voltage and frequency transients on time-based plot for step loads based on figure 6 of ISO 8528. Record voltage and frequency transient response and ensure compliance with category **[G2][G3]**.
8. Total harmonic distortion of phase to neutral voltages at no load and 100 percent rated load.

PART 3 - EXECUTION

3.1 EXAMINATION

A. With Installer present, examine areas, equipment foundation, and conditions for compliance with requirements for installation and other conditions affecting packaged engine generator performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine roughing-in of cooling-system piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

3.2 INSTALLATION

A. Comply with packaged engine generator manufacturers' written installation and alignment instructions, and with NFPA 110.

B. Equipment Grounding: All non-energized metal parts of genset must be electrically bonded together and connected to genset ground stud. Connect generator frame to ground stud.

C. Where installed indoors, locate sound attenuators and plenum walls minimum of 0.75 meters from intake louvers and screens to allow access for cleaning. Engine radiator to be connected to ductwork with flexible connection and no less than 1:4 transition to the sound attenuator.

D. Verify that intake motorized damper is operational and programmed to open prior to generator startup.

E. Verify that either a backdraft damper on radiator discharge is installed to open in direction of airflow, or that motorized damper is operational and programmed to open prior to generator startup.

F. Verify day fuel tank controls are operational for fuel oil filling.

3.3 CONNECTIONS

A. Connection Tag: Contractor must verify nameplate and connections prior to connection of cables and other elements of the system.

B. Hoses and Hose Fittings: Install hoses with no sharp bend or twisting, and without contact with any adjacent structures to avoid rubbing.

C. Piping Installation: Construction Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install fuel oil piping adjacent to packaged engine generator in trench to allow service and maintenance. Fuel oil piping between day fuel tank and generator is not to route high in room to prevent flooding of the fuel injectors.
2. Install day fuel tank primary, emergency and secondary containment tank vents to outside of building with security tank vent caps at vent discharge.
3. Connect engine exhaust-system piping to diesel engines. Install engine exhaust piping accessories (muffler and ventilated thimble) in accordance with Mechanical details and manufacturer’s recommendations. Install tap and drain valve at base of vertical risers in the building.

3.4 IDENTIFICATION

A. Nameplates: Provide permanently attached nameplate in accordance with ISO 8528-5 mounted in visible location on outside of genset. Nameplate must include winding wound with 2/3 pitch.

3.5 FIELD QUALITY CONTROL

A. Pretesting: Upon completing installation of system, align, adjust, and balance system, and perform complete start-up and pretesting. Determine, through pretesting, conformance of system to requirements of contract, and to Construction Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning and damaged items with new, and retest (at no cost to Government) until satisfactory performances and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

B. Report of Pretesting: After pretesting is complete, provide letter certifying installation is complete and fully operable; include names and titles of witnesses to pretests.

3.6 COMMISSIONING

A. Manufacturer's Field Service: Engage factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to assist in testing. Report results in writing.

B. Testing: Perform generator and day fuel tank field quality-control testing under supervision of the manufacturer's factory-authorized service representative.

C. Tests: Include those identified above in Article on SOURCE QUALITY CONTROL and the following:

1. Tests recommended by manufacturer.

2. Exclude Source Quality Control test for operation at 110 percent of rated load for one hour if there is no 110 percent loading available on site.
3. InterNational Electrical Testing Association Tests: Perform each visual and mechanical inspection and electrical and mechanical test in NETA ATS for emergency generator sets, except omit vibration baseline test. Certify compliance with test parameters for tests performed.
4. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
5. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
6. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
7. System Integrity: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
8. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 120 kPa (40 inches w.g.). Connect to exhaust line close to engine exhaust manifold. Verify back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach label or tag to each tested component indicating satisfactory completion of tests.

G. Test instruments must have been calibrated within last 12 months, traceable to standards of National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

3.7 CLEANING

A. Cleaning: Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.8 DEMONSTRATION AND TRAINING

A. After completion of commissioning responsibilities, provide services of Manufacturer's factory-authorized service representative to demonstrate and train post maintenance personnel. Provide minimum of 8 hours training. Refer to Division 01 Section “Demonstration and Training.”

1. Train on procedures and schedules for operating, troubleshooting, servicing, and preventive maintenance of system, and for equipment isolation and de-energization procedures.
2. Refer to Article on ARC FLASH TRAINING in Section 260573 “Overcurrent Protective Device Coordination Study” for associated training requirements.
3. Review data in maintenance manuals.
4. Schedule training with the Project Director/COR with at least seven days advance notice.

END OF SECTION 263214

SECTION 263237 – RESISTIVE LOAD BANKS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes forced air-cooled resistive load bank. These units shall provide manual exercising system for engine generators.

B. Related Sections include the following:

1. Division 26 Section on “Vibration and Seismic Controls for Electrical Systems.”

1.2 SUBMITTALS

A. Product Data: Provide physical data of load and control enclosures including dimensions, weights, cable access, mounting, operating clearances, and details of component arrangements.

B. Wiring Diagrams: Provide detailed wiring diagrams of power and control circuits, including point-to- point wiring, wire numbers, connection point identification, components labeled by device legend.

C. Manufacturer Seismic Qualification Certification: Submit certification that load bank will withstand seismic forces defined in Division 26 Section on "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Provide certification based on test of prototype.
2. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
3. The term "withstand" means "unit will remain in place without separation of internal and external parts during seismic event and the unit will be fully operational after event."
4. Dimensioned Outline Drawings of Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.
5. Detailed description of equipment anchorage devices on which certification is based, and their installation requirements.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Product Test Reports: Certified copies of manufacturer’s design and routine factory tests required by referenced standards.

F. Sound-Level Test Reports: Certified copies of manufacturer’s sound-level tests applicable to equipment for this Project.

G. Maintenance Data: For equipment to include in maintenance manuals. Include the following:

1. Lists of spare parts and replacement components recommended for storage at Project site.

1.3 QUALITY ASSURANCE

A. Comply with requirements of the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.4 PROJECT CONDITIONS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for load bank, including clearances. Comply with indicated maximum dimensions.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: **[-10 deg C to 50 deg C.]**
2. Altitude: **[620m above sea level.]**
3. Relative humidity: **[Up to 60 percent non-condensing.]**

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. The Load Bank shall be complete system with all necessary pilot and power control wiring, and devices to provide functional system. The only additional wiring shall be site required electrical wiring to power source and interconnections from control panel to load enclosure.

B. Load bank is required for all paralleled generators and other single generator systems.

C. The load bank shall have capability of load testing engine generator lineup up to 100 percent rating of single generator unit, to verify its performance and supplemental load system.

D. Sound Levels for noise shall conform to requirements in Chapter 12 of the OBO Building Code.

1. Provide Screen Wall attenuation to achieve STC 60 at screen line.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Load Technology, Inc. (LOADTEC).
2. ASCO Power Technologies
3. Cannon Load Banks.
4. Kohler Co.

2.3 CONFIGURATION

A. The load bank shall consist of the following items:

1. Load bank enclosure containing load resistors, cooling fans, and power control devices.
2. Control panel containing required pilot controls and indicators.

B. Refer to Construction Drawings for location of load bank enclosure and control panel.

2.4 RATINGS

A. Rating shall correspond to 100 percent of one generator KW output rating at 1.0 power factor.

B. Load steps shall be rated at 25 percent, 50 percent, 100 percent, or combination of these steps.

C. Duty cycle shall be continuous at rated ambient conditions.

D. Tolerances:

1. Total: Plus or minus 5 percent of nominal rating.
2. Balance: Plus or minus 2 percent of mean phase.

2.5 ENCLOSURES

A. Load Enclosure:

1. Enclosure shall be suitable of outdoor installation, with bolt down provisions for permanent mounting to concrete pad.
2. Provide enclosure with lifting eyes and captive fork lifting tubes.
3. Discharge air flow from the unit shall be vertical. Unit shall be constructed to prevent re-circulation of cooling air.
4. Fabricate enclosure to isolate heated air flow through load resistor chamber, from control section containing power control and distribution components.

5. Control Section:

a. [Low and Moderate Atmospheric Corrosivity Levels: NEMA 3 rated with gasketed access doors. Load section shall be NEMA 3R with fixed louvers and guards on intake and exhaust openings.]
b. [Extreme Corrosivity Levels]: NEMA 4X.]

6. Enclosure shall have adequate space to install the conduits from the power source. .
7. Enclosure shall be fabricated of electroplated galvanized steel or aluminized steel. Exhaust louvers, if used, shall be fabricated of stainless steel.

B. Stand Alone Control Enclosure:

1. Stand alone control enclosure shall be indoor type, suitable for wall mounting.
2. Enclosure shall be NEMA 3 rated with hinged and gasketed access door.
3. All control components shall be sub-panel mounted with pilot controls and indicators mounted and wired to the exterior door.

C. PLC integrated control enclosure:

1. Coordinate controls with PLC cabinet enclosure.
2. Provide for loadbank control from exterior of cabinet under normal operation. All control components shall be sub-panel mounted, with pilot controls and indicators mounted and wired to exterior.

D. Paralleling Switchgear Control:

1. Coordinate controls with switchgear enclosure.
2. Provide for load bank control from exterior switchgear under normal operation. All control components shall be sub-panel mounted, with pilot controls and indicators mounted and wired to exterior door of single cubicle.

E. Paint:

1. Metal surfaces shall be properly prepared, primed, and painted. There shall be no raw surfaces except for stainless steel or panels that have platings.
2. Prepare surfaces to be painted in accordance with the Society for Protective Coatings (SSPC) Surface Preparation requirements:

   a. Standard SP1.

3. Prime surfaces to be painted using etching primer intended for use on galvanized steel, and applied in accordance with manufacturer's recommendations.
4. Provide finish coat on primed surfaces using exterior U.V. resistant polyurethane enamel paint applied in accordance with manufacturer's recommendations.

2.6 LOAD RESISTORS

A. Load resistors shall be open wire wound type that are continuously supported length of resistor structure. If resistor alloy should fail, resistor material shall be held captive to prevent contact with any surrounding resistors or ground.

B. Resistor's continuous support shall consist of segmented ceramic tubes assembled on stainless steel rods with fastening provided to compensate for thermal expansion of ceramic tubes.

C. Resistors shall be fabricated of corrosion resistant chromium alloy that has minimum continuous operating temperature of 1000 deg C.

D. Resistor shall not operate at any point in excess of 67 percent of alloy's maximum continuous operating temperature at ambient extremes.

E. Resistors shall be installed in multiple field removable trays that are small enough to facilitate easy maintenance. Each tray shall be individually removable without affecting any adjacent tray.

F. Resistor terminals shall be brought to exterior of tray through high grade electrical ceramics. No plastic or polyester glass laminates shall be used in any part of resistor assembly.

G. Resistor terminations shall be formed from alloy material or have fabricated terminals of similar material welded to alloy.

H. Resistors shall not require cool down period. Failure shutdown of cooling fan during operation of resistors shall not shorten their life expectancy.

2.7 COOLING SYSTEM

A. Load Bank shall be of forced air cooled type.

B. Cooling fan(s) shall be one piece cast aluminum.

C. Fan(s) shall be direct driven by three phase, TEFC, induction motor.

1. Motor shall be rated at maximum brake horsepower of fan propeller for applied static pressure load.

2.8 PROTECTIVE SYSTEM

A. Cooling failure:

1. Provide failure circuit to monitor cooling system operation, and to disconnect load steps before damage can occur.
2. Provide airflow switch for each cooling fan to monitor fan operation.
3. Provide temperature switch at load chamber exhaust of each cooling fan to monitor excessive exhaust temperature.

B. Fuses:

1. Fuse each individual load section/load step to protect its wiring and control device.
2. Provide required fuses to protect control power transformer and wiring.

C. Cooling fan:

1. Each cooling fan shall be protected by thermal magnetic molded case circuit breaker in combination with contactor and thermal overload relay.

2.9 WIRING AND LOAD BUS

A. Wiring:

1. Load wiring shall have minimum rating of 150 deg C.
2. Control wiring shall have minimum rating of 105 deg C.
3. Wire shall be sized at 125 percent of maximum ampacity at rated ambient.
4. Control wiring shall have sleeve wire numbers that are identified on wiring diagrams.
5. Terminate external interconnect wiring at barrier terminal blocks.

B. Load Bus:

1. Main bus shall run length of control section of load enclosure so that bus mounted fuses will require only short jumpers to load contactors.
2. Load bus shall be tin or silver plated copper and sized for temperature rise at full ampacity rating of load. Load bus shall have maximum temperature rise of 35 deg C.
3. Provide mechanical lugs to connect power source. Number and size of lugs shall accept number and size of the conductors shown on Construction Drawings.
4. Provide mechanical lugs to accept required equipment grounding conductors shown on Construction Drawings.

C. Ground Load Bank in accordance with the OBO Electrical Code

2.10 POWER CONTROLS

A. Load shall be controlled by contactors capable of continuous and cycling operations.

B. Control devices shall be clearly and permanently labeled.

2.11 PILOT CONTROLS

A. Provide required control circuitry needed to achieve functions described for control switches and indicators.

B. Display: Panel consists of the following components:

1. LCD Graphics Display Screen
2. Control Keypad
3. Audible Input Signal
4. LED General Operational Indicators
5. Lamp & Graphical Display Test
6. The LCD Display provides:

a. Soft Key Legend
b. Metering display
c. Operational Mode
d. Operational status and alarm condition details

C. Exterior control devices shall be permanently and clearly marked for function and operational settings. Control devices shall be clearly and permanently labeled on interior of enclosure.

D. Control switches and indicators shall be industrial oil tight type if control enclosure is not mounted inside an appropriately NEMA rated control compartment within load bank.

E. Locate control and monitor adjacent to or within paralleling switchgear lineup, adjacent to or integrated with PLC control panel, or stand alone when no PLC or paralleling switchgear is present.

F. Provide ethernet port and serial ports for optional remote monitoring or control.

G. Control panel shall have the following control switches:

1. Control Mode Switch to select operational mode of system. Switch shall have the following three positions for functions:

   a. AUTO Position: Load bank shall automatically drop connected load steps, and be ready to respond to requirements of sequence of operation for power as defined in Division 26 Section for Utility/ATS, in event of utility power failure or other cause that requires power source to service its normal loads. Loadbank control in AUTO shall also be controllable by PLC for paralleling generator switchgear for adding or removing load in normal operation and in test conditions.
   b. OFF Position: Load bank shall be locked out and all circuits reset.
   c. MANUAL Position (to be used only for testing of generators in presence of operator): Load bank shall automatically drop connected load steps in event of utility power failure or other cause that requires power source to service its normal loads. In this case, operator shall manually change position of Control Mode Switch from the MANUAL position to AUTO position. Load bank shall then be ready to respond to requirements of sequence of operation as defined elsewhere.

2. Automatic load sequencing.
3. Fan Control/Cooling Failure Reset switch to control cooling fan(s), and reset any cooling failure alarms. Switch shall be three positions for functions of Off-On- Reset (momentary).
4. Master Load switch, which allows simultaneous control of preselected load steps.
5. Load Step switches to control each load step.

H. Control lineup shall have the following indicators:

1. Fan running indicator with green lens to annunciate if fan(s) is running.
2. Cooling failure indicator with red lens to annunciate fault condition.
3. Load Step indicators with blue lenses to annunciate energization of each load step.
4. Metering for load bank time and operation

a. True RMS
b. Voltage each Phase
c. Voltage Average
d. Current each Phase
e. Current Average
f. Frequency
g. Kilowatts Average

I. Auxiliary Contacts

1. Generator Normal Operation
2. Generator Failure
3. Generator Start
4. Common failure

2.12 CONTROL POWER

A. Control Circuits:

1. Control power shall not exceed 240 volts.

B. Fan Power:

1. Fan power shall be facility power characteristics. Coordinate number of required circuits and ratings with equipment supplier.

C. Thermal overload relays with thermal magnetic circuit breaker for protection and disconnect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install load enclosure and control panels in accordance with manufacturer's drawings and instructions in location shown on Construction Drawings.

B. Install power and control wiring in accordance with manufacturer's drawings and instructions.

C. Install control wiring to paralleling switchgear PLC controller.

D. Install switch, within sight of load bank, to disconnect all power to load bank during servicing.

3.2 FINAL ACCEPTANCE

A. Load Bank system shall be adjusted and inspected in accordance with manufacturer's initial operation instructions.

B. Entire system shall be operated to demonstrate function of each control panel and accuracy of applied load.

1. Operate each failure sensor to demonstrate operation of safety system.

END OF SECTION 263237

SECTION 263313.11 – RESIDENTIAL ENERGY STORAGE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the Energy Storage System (ESS) for residential applications and their associated internal components that create the entire system, including inverters, power conversion systems, microgrid interconnect devices, energy storage components, monitoring and control systems, miscellaneous electrical equipment, associated integral HVAC, Fire Protection and Fire Alarm Systems.

B. Related Sections include the following:

1. Section 230905 "Instrumentation and Controls for HVAC"
2. Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety"
3. Section 260518 "Low-Voltage Electrical Power Conductors and Cables"
4. Section 260525 "Grounding and Bonding for Electrical Systems"
5. Division 26 Section on raceways and boxes for conduits and outlet boxes
6. Section 260573 “Overcurrent Protective Device Coordination Study”
7. Section 260915 "Electrical Power Monitoring"
8. Division 26 Section on Enclosed Switches and Circuit Breakers
9. Division 26 Section on Fuses
10. Section 262214 "Low-Voltage Transformers"
11. Section 263105 "Solar Photovoltaic Systems"
12. Division 26 Section on “Vibration and Seismic Controls for Electrical Systems”

1.2 REFERENCE STANDARDS

A. In addition to standards identified elsewhere in this Section and related Sections, conform to the following:

1. America National Standards Institute (ANSI)

   a. ANSI-C12.1 “Std. for Electricity Meters”

2. Institute of Electrical and Electronics Engineers (IEEE)

   a. IEEE-1547 “Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces”
   b. NESC “National Electrical Safety Code”

3. National Electrical Installation Standards (NEiS)

a. NECA-405 "Std for Installing & Commissioning Interconnected Generation Systems"
b. NECA-416 "Recommended Practice for Installing Energy Storage Systems"
c. NECA-417 "Std for Designing, Installing, Operating, & Maintaining Microgrids"
d. NECA-701-13 "Std for Energy Mgmt., Demand Response & Energy Solutions"

4. Electrical Manufacturers Association (NEMA)

a. NEMA-250 "Enclosures for Electrical Equipment (1.0 kV Maximum)"

5. National Fire Protection Association (NFPA)

a. NFPA-855 "Std for the Installation of Stationary Energy Storage Systems"
b. NFPA-780 "Std for the Installation of Lightning Protection Systems"

6. Underwriters Laboratories, Inc. (UL)

a. UL-1642 "Std. for Lithium Batteries"
b. UL-1741 "UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources"
c. UL-1741SA "Standard for Safety Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources – Supplement A"
d. UL-1973 "Batteries for Use in Stationary and Motive Auxiliary Power Applications"
e. UL-9540 "Energy Storage Systems and Equipment" (ESS)
f. UL-9540A "Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems"

7. OBO Electrical Code (NFPA 70, "National Electrical Code" including amendments by OBO); reference Article 706 Energy Storage Systems, Article 705 Interconnected Electric Power Sources, and other Articles as applicable.
8. OBO Fire Code (International Fire Code including amendments by OBO); reference model code Section 1207 "Electrical Energy Storage Systems" and others as applicable.
9. OBO Residential Code (International Residential Code including amendments by OBO); reference model code section R328 "Energy Storage Systems" and others as applicable

1.3 DEFINITIONS

A. BESS: Battery Energy Storage System

B. BMS: Battery Monitoring System

C. EMS: Energy Management System

D. ESS: Energy Storage System

E. MCS: Microgrid Control System

F. NIST: National Institute of Standards and Technology

G. O&M: Operation and Maintenance

1.4 SUBMITTALS

A. Product Data: For Energy Storage System components. Include: Technical data on features, performance, electrical characteristics, ratings, weights, and finishes; rated capacities, operating characteristics, furnished specialties, and accessories; Factory published product specification data sheets; list of materials and components; UL listed data and certifications.

1. Energy Storage System components include but are not limited to:

a. Energy storage system cells, modules, units, stacks, membranes, and balance of system
b. Inverters, converters, and optimizers
c. Microgrid interconnect devices and controllers
d. Charge controllers
e. Energy management system and controllers
f. Switchboards, enclosed switches, panelboards, and their overcurrent protective devices
g. Fire protection and fire alarm system devices
h. Mounting equipment cabinets, racks, and containers
i. HVAC system components
j. Miscellaneous materials and equipment

B. Shop Drawings: Project specific for ESS and related equipment, include the following:

1. ESS description, including the following:

a. ESS chemistry, major component descriptions and their role to achieve required mode of operation
b. Nameplate data, manufacturer, catalog numbers, and all major accessories used in the system
c. System electrical characteristics: usable energy storage capacity; rated power; AC efficiency (including auxiliary loads); cycle life; and annual degradation factor.
d. Fire protection/suppression system and fire alarm description including plan for thermal runaway detection and mitigation
e. Ambient temperature control system and environmental condition parameters

2. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Site plan or floor plan showing the ESS location including dimensions, access, and auxiliary HVAC units.
b. ESS Cabinet/Container system dimensions including climate control units mounted on the side.

c. ESS assembly and equipment layouts
d. Centerlines for all external conduit and grounding cable connections, and wall/floor/roof penetrations for auxiliary equipment.
e. Sections and elevations with height of components/container from floor level to top of components/containers highest non-moveable point.
f. Mounting system.
g. System weight, including subtotals by area
h. Shipping center of gravity for each container and major equipment
i. Construction staging and storage areas.
j. Owner requirements for all control and auxiliary equipment
k. Fire protection and fire alarm system layouts

3. Structural Certification: Certification by licensed structural engineer demonstrating ability of a structure to support all loads required for the ESS.
4. Electrical studies and schematic diagrams, include the following:

a. One-line diagram between major ESS components and interconnection to electrical distribution, including identification of DC versus AC-coupling.
b. Control wiring diagrams, with cross reference for checking and verifying all the control circuit and wiring diagrams, along with the terminal designations for termination of the field wiring of all equipment.
c. Communication and control diagrams.
d. Electrical studies to determine control response and settings, including load flow analysis, short circuit coordination, ampacity, and arc flash analysis in coordination with Section 260573 Overcurrent Protective Device (OCPD) Study

5. ESS component equipment covered by other specification sections must comply with submittal requirements of the relevant specification section (i.e.: panelboards, switchboards, HVAC equipment, fire protection, fire alarm, enclosed switches, etc.).

C. Certificates of compliance: Provide certificates of compliance for referenced standards, and reports for referenced testing standards.

D. Qualification Data:

1. Support services vendor: Identify vendor firm name and contact, location, distance from project, years, and servicing product line.

E. Field Test reports: Submit written test reports, include the following:

1. Functional test procedures used.
2. Final test results. Include all test results and demonstrate their comparison to and compliance with requirements.
3. Report must include results of all failed tests and corrective action taken to achieve test results that comply with requirements.

F. Commissioning Test reports: Submit written test reports, include the following:

1. Commissioning test procedures tailored to the storage chemistry and operational performance.
2. Final commissioning test results and Commissioning Issues Log described in part three of this specification.
3. Commissioning test report must include results of all failed tests and corrective action taken to achieve test results to comply with requirements.

G. Operation and Maintenance Manuals:

1. In addition to the items specified in Division 01, Section 017825 *Operations & Maintenance Data* include the following ESS documentation:

   a. ESS equipment and components: Include description of unit or system, recommended maximum depth of discharge (DoD) and degradation rate, and component parts. Give function, normal operating characteristics, and limiting conditions.
   b. Provide approved engineering submittals. Include equipment sizing calculations.
   c. Provide manufacturer's installation wiring diagrams and schematic diagrams.
   d. Operating procedures: Include routine normal operating instructions and sequence of operations. Include regulation, control, stopping, shutdown, system balancing and maintenance (i.e., full discharge and slow charge) and emergency instruction.
   e. Special or recommended operating procedures to minimize energy storage capacity degradation over time with respect to seasons, depth of charge/discharge, voltage, humidity, etc.
   f. Maintenance requirements: Include required materials, routine procedures and guide for cleaning, troubleshooting, equipment isolation, lockout, tagout, and ESS adjusting, balancing, and checking instructions.

2. ESS Fire protection procedures and instructions for authorized personnel and local firefighting personnel.

H. Record Documents: As specified in Division 01, Section 017705 *Closeout Procedures*.

1. Final as-built drawings and information
2. Assembly and wiring diagrams
3. Installation and operation information
4. Training materials for the operation and maintenance (O&M)

1.5 QUALITY ASSURANCE

A. Qualifications

1. The manufacturer of the ESS must be a company specializing in the manufacture of ESS equipment and have at least (5) continuous years of documented experience with their hardware in commercial applications in the field.
2. Installation personnel: submit evidence prior to work that persons performing the work herein have manufacturer approved training and qualified experience in ESS installation, design, and applicable safety procedures, and hold proper licenses where applicable.

3. Commissioning personnel: Provide qualifications including experience of certified personnel responsible for ESS startup and commissioning work.

B. Listing and labeling:

1. Electrical components, devices, and accessories must be listed and labeled in accordance with a qualified testing agency and marked for intended location and application.
2. Certificates of compliance: Provide certificates of compliance for referenced standards.
3. Applications and installations must comply with the requirements of the codes and standards listed in this Section. Where required, certified test reports substantiating the compliance must be submitted upon request.

C. Support Service Capability:

1. ESS manufacturer must maintain a call center for technical and emergency support for this system.
2. ESS manufacturer must provide authorized field service vendor with factory-trained personnel for startup, maintenance, and repair of ESS and related equipment.
3. Availability of Service personnel: Manufacturer must have worldwide service organization, with authorized factory-trained service personnel available within to provide support remotely 24 hours a day, 7 days a week, 365 days a year, and ability for onsite service.
4. Availability of Spare Parts: Manufacturers must have worldwide robust supply chain for components and system distributorships, with replacement parts available from manufacturer using their regularly available expediting delivery for receipt within 48hours of request.

D. All materials supplied for this project must be new.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment must be handled and stored in accordance with manufacturer's instruction, and as required to prevent any damage to system components and electronics. One (1) copy of these instructions must be included with the equipment at time of shipment.

B. Prior to and during construction, provide secure storage onsite for all ESS materials.

C. If stored in areas subjected to weather, cover equipment to provide protection from weather, dirt, dust, corrosive substances, and physical damage.

D. Where systems are intended for use in classified areas, appropriate considerations must be taken in the delivery, storage, and handling of the equipment.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Temperatures:

   a. Annual ambient: **[enter site specific value]** deg C to **[enter site specific value]** deg C.
   b. Record low temperature: **[enter site specific value]** deg C.
   c. Record high temperature: **[enter site specific value]** deg C.

2. Altitude: Derate as required if over **[enter site specific value]** meters above sea level
3. Relative humidity: **[enter site specific value]**
4. **[enter other site-specific conditions such as wind ratings, sand/dust, seismic activity, salt air, fog, marine corrosiveness, etc.]**

1.8 COORDINATION

A. Coordinate layout and installation of ESS with other construction, including conduit, piping, equipment, and adjacent obstructions and surfaces. Maintain required clearances for workspace and equipment access.

B. Coordinate size and locations of anchor-bolt inserts into concrete slabs.

C. Provide system technical coordination for utility interconnection agreements. Provide grid connection as required, and in location as designated by local utility company.

D. Coordinate electrical voltage (V), phase (Ø), and hertz (Hz) characteristics of ESS's output with electrical characteristics of local utility company, and with ESS's input if bidirectional inverter is used.

1.9 WARRANTIES

A. Provide ESS extended (10) year manufacturer's warranty (excluding energy storage modules) valid from the date of substantial completion.

B. Energy storage module(s) warranties: Extended (10) year warranty after the date of substantial completion. Battery pack must retain at least **[70 percent] [enter other percent nominal capacity]** of nominal energy capacity for the earlier of either (10) years after commissioning or after a minimum energy throughput of **[insert cumulative throughput]** kWh energy.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. The US Government must retain all rights to software and passwords used for this project.

B. Contractor must provide a copy of the manufacturer's standard software and end-user license agreement (EULA) for review and approval as condition of this contract. Such license must grant use of all programs and application software to the US Government as defined by manufacturer's license agreement but must protect manufacturer's rights to disclosure of Trade Secrets contained

within such software. The Contractor must obtain a signed copy of the manufacturer's software and firmware licensing agreement prior to purchase.

C. The licensing agreement must not preclude use of software by individuals under contract to the US Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to the US Government will be restricted to use on the US Government's computers and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation must become the property of the US Government.

1.11 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date, provide 12 months full maintenance by authorized field service vendor with factory-trained certified personnel. Provide system maintenance service with adjusting as required for proper operation based on manufacturer's recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. Provide parts and supplies same as those used in the manufacture and installation of original equipment. In addition to the initial year of maintenance service, provide a proposal for a five-year period with (5) one-year, annually renewable periods, starting from end of initial maintenance period. The option year proposal must be submitted **[120]** days prior to the end of the maintenance contract period.

B. Maintenance service must include preventive maintenance, repair, or replacement of worn or defective components, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks must also align with the manufacturer's recommended checklists as required in Division 01, Section 017825 *Operations & Maintenance Data*. Provide complete maintenance records inclusive of scheduling to the US Government for inclusion in the Computerized Maintenance Management System (CMMS).

C. The Maintenance Service must include an annual report to US Government verifying that the ESS is performing as intended per the battery storage strategy and manufacturer recommendations. The report must include:

1. Use case performance
2. Battery outages with root cause summary/failure modes and effects analysis, start and end time periods.
3. Summary of all O&M operations; repair and replacements
4. Summary of safety incidents, causes and resolutions
5. Contractor must perform all required maintenance to the ESS and BMS to ensure that the monthly demand reduction is provided.
6. In addition to required demonstration and training in PART 3 of this specification, the Contractor must provide an additional eight (8) hours O&M training session to the US Government O&M personnel prior to the completion of the initial 12 months of maintenance service. Training must comply with PART 3 and cover issues and resolution

encountered during the initial 12 months of maintenance service by service maintenance staff and US Government O&M.

7. Perform updates to the battery management system dispatch strategy if required due to rate tariff or major site load profile changes.
8. Ensure that all system firmware is up to date and meets US Government cybersecurity requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Enphase IQ
2. SolarEdge Home
3. Sonnen Core
4. Tesla Powerwall
5. **[other manufacturer]**

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if accepted by the Project Contracting Officer Representative (COR) and Engineer **[(10)]** calendar days prior to bid date. Submit alternate manufacturer for review to allow **[(14)]** calendar days for review with sufficient documentation demonstrating compliance with project requirements.

C. The design drawings must include details, equipment dimensions, and space requirements based on the **[first listed acceptable manufacturer]**. If the Contractor selects a different equipment supplier, some redesign including locations of conduits, terminations, and space clearance may be required. Additional costs incurred for these changes must be borne by the Contractor.

2.2 GENERAL REQUIREMENTS FOR ESS

A. ESS must be listed for the intended use in accordance with OBO-ICS NEC Chapters 1 and 7.

B. ESS must be UL-9540 listed and tested in accordance with UL-9540A where required by UL-9540.

C. Provide Nameplate, System drawing, mimic bus, and arc flash ratings to be located on the doors of containers, equipment, or cabinets.

1. The System must have a **[enter kW rating]** kW-AC rating and **[enter kWh rating]** kWh-AC usable rating.

2. The System AC Voltage must be **[enter system voltage]** volts.

D. Exposed Conduit: All exterior exposed conduits must be galvanized rigid steel (RMC) with threaded fittings.

E. ESS Output: ESS must match local utility company exactly in voltage, phase, and frequency to allow it to be grid-tied in accordance with local utility company's safety and power quality requirements. Coordinate all requirements with local utility company. Refer to Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety" for additional metering requirements.

F. The ESS must contain protective relays, circuit breakers, or fuses which self-protect the ESS in the case of internal electrical faults. Set and adjust circuit protection devices according to a short circuit and coordination study.

G. A visible disconnect will be installed that isolate the ESS from utility interconnection, complying with local utility requirements.

H. Grounding: Contractor must provide grounding system for personnel protection for step and touch potential complying with IEEE-Std-80. The system also must be adequate for the detection and clearing of ground faults within the ESS. The system should be grounded in all anticipated operating modes (e.g., grid-tied, and islanded).

I. The ESS must be capable of grid forming for microgrid islanding applications, complying with all local utility requirements, and compatible with other power generating sources.

J. Seismic Performance: ESS must withstand effects of earthquake motions determined according to ASCE/SEI 7.

1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operation after the seismic event.”

2.3 PERFORMANCE REQUIREMENTS

A. Integrate the ESS with the following power generation systems and **[existing]** power distribution system

1. **[enter kW nameplate capacity]** Photovoltaic system(s)
2. **[enter kW nameplate capacity]** Generator(s)
3. **[enter kW nameplate capacity]** Wind Turbine system(s)
4. **[enter kW nameplate capacity]** Fuel Cell(s)
5. **[enter other power generation]**

B. The ESS must operate for the following scenario(s):

1. Demand control: The ESS must provide grid electricity usage and demand/peak shaving to limit demand (kW) to programmed setting.

a. **[Anticipated] [Current]** site monthly peak demand is **[insert monthly peak kW demand]**, and average load is **[insert average demand in kW]**. Limit grid demand by **[specify the required demand reduction in kW.]**. The ESS must have a method for forecasting the peak load and automatically dispatching the battery or scheduling the charge/discharge in advance.
b. Time of Use Charge Reduction: Integrate the ESS to discharge during on-peak or mid-peak hours in accordance with the site's rate tariff and the resiliency requirements of the site.
c. ESS must maintain a round-trip efficiency greater than **[70][90]** percent AC-in to AC-out (confirmable by operation over a single round-trip cycle from 0 percent state of charge to 100 percent, and back to 0 percent at standard conditions specified by the manufacturer), including thermal losses and auxiliary loads, over 10 years.
d. Annual ESS savings will be generated by discharging the battery during on-peak periods, as well as during peak billing demand periods.
e. Grid stability by ramping up and down ESS output in response to utility grid frequency.

2. Grid outage: The ESS must support critical loads in microgrid operation in the event of a grid outage.

a. Install a microgrid control system and modify existing electrical distribution and automatic transfer schemes as necessary to provide electricity to the building upon grid failure. The Contractor must include the creation of a critical power circuit, including re-wiring of the critical loads and installation of critical power switchgear, in the scope of work (SOW).
b. The ESS must support the critical loads **[as indicated on drawings]**
c. The ESS must perform anti-islanding sequence and grid forming operation to enable microgrid mode with "black start" capability.
d. The ESS controller must disconnect load to prevent overload or over discharge and must manage charge/discharge function when utility grid is re-established.
e. Consider the following site-specific parameters in the system design:

1) **[Specify site-specific operating conditions: provide electric load interval data, required ramp rates for existing generators, additional information on the types of loads to be served and required modes of operation. Provide detail on existing control and monitoring systems.]**
2) Configure ESS to provide seamless transition between utility power and microgrid.
3) Optimize system to minimize generator use to conserve fuel.

2.4 ENERGY STORAGE COMPONENTS

A. Energy storage components must consist of **[lithium-ion batteries] [nickel-cadmium batteries] [nickel metal hydride batteries] [flow batteries] [lead-acid] [other battery or electrochemical ESS technology]**.

B. Energy storage systems may be individual cells, and supplied as modules comprised of cells, or as group of modules combined into units. Several units may be combined to make up the balance of the system. Cells, modules, and units must be fully enclosed in listed assembly for the intended purpose. Individual battery trays and/or racks must not be permitted.

C. Energy storage systems comprised of battery systems must be UL-1973 listed for the intended use.

D. A battery management system must monitor and balance cell voltages, currents, and temperatures within the manufacturer's specification. The battery management system must be part of the ESS component UL listing. The battery management system must perform the charging and discharging of the equipment. The BMS must be field programmable via laptop and viewing/editing on a locally hosted web browser. Programming instructions and setpoints must be shared with Agency staff.

E. [The battery management system charge controller must have Maximum Power Point Tracking (MPPT) for DC coupled PV systems.]

F. The cells, modules, units, and installation must be supplied with all required and/or manufacturer recommended accessories.

G. ESS DC voltage must not exceed **[1000Vdc] [1500Vdc] [other DC voltage]**.

H. The use of vented batteries must not be permitted.

2.5 POWER CONVERSION SYSTEMINVERTERS

A. Power Conversion System (PCS) must be UL-1741 or UL-1741SA listed for the intended use.

B. PCS output must match local utility company frequency and voltage when grid tied to local utility or in combination with **[generator operation] [microgrid control system]** where applicable.

C. PCS output connections and operation must comply with all local utility company requirements.

D. PCS must have the following electrical characteristics:

1. Efficiency: minimum 95 percent.
2. Frequency: 50/60 Hz
3. AC Voltage range: matching utility voltage
4. DC Voltage range: matching energy storage DC voltage
5. THD: < 3 percent
6. Power factor: -1 to +1

E. The PCS must have the following features to operate in the required performance scenario(s):

1. Perform grid-tie and grid-forming operation with "black start" capability and seamless transfer.

2. Bi-directional charge and discharge of the ESS with intelligent controls and interface with battery management system.
3. Complete automatic unattended operation including startup, synchronization, power disconnect, and parallel operation with the utility **[and generators]**. **[Where applicable, the system must also operate in parallel with: [photovoltaic systems,] [generators,] [other site power production,]and utility]**.
4. Shutting down without damage when ESS output is outside tolerance parameters of inverter.
5. Automatic anti-islanding in conformance with referenced standards.
6. [other features]

2.6 MICROGRID CONTROL SYSTEM (MCS)

A. The MCS may be a separate component or combined with the ESS or inverter. The MCS must be one of the following: be listed, listed individual components assembled as a system, or designed under engineering supervision.

B. The MCS must include an energy management system (EMS), when an additional onsite generating source is present (i.e., solar or generators).

C. The MCS must have the following features to achieve the intended performance scenario(s):

1. Communicate with the ESS intelligent controls and monitor energy contribution from the **[Photovoltaic system], [generators], [other site power production].**
2. Monitor, log and report the energy consumption load profile.
3. The EMS must balance the power generation inputs, load outputs and signal controls to achieve the intended performance scenarios including grid services (such as peak demand shaving and energy arbitrage) and backup power to meet resiliency requirements.
4. Must autonomously initiate anti-islanding and grid forming sequence with battery power conversion system, generator controllers, or grid-forming inverters to operate in microgrid mode.
5. Ability to control the quantity and ratings of generation sources, utility, and output loads as indicated on drawings.
6. Communicate with, and directly control, connected generation sources including PV inverters, generator control panels, and battery converters. The MCS must be capable of coordinating the interaction between multiple power sources of similar or different types, manufacturers and technologies utilizing industry standard communication protocols.
7. Provide local and remote monitoring capability complying with this specification.
8. Be housed within the ESS or in separate enclosure complying with environmental conditions in this specification.
9. Include a programmable onsite interface to adjust the operating modes and threshold values.
10. Ability to log and export historical data from each connected generation source.

2.7 VENTILATION AND AIR CONDITIONING (HVAC)

A. The ESS must be naturally ventilated with openings or through forced air to maintain operating conditions within installed locations complying with manufacturer ambient conditions.

2.8 ENCLOSURE

A. The ESS and associated equipment must be in a factory assembled enclosure that is rated for the site conditions.

B. The ESS, and associated equipment, must be provided in self-contained NEMA **[3R] [4X]** enclosure(s) rated for the site conditions. ESS enclosures must be designed to be installed onto properly prepared pads/foundations or walls.

C. Provide manufacturer **[standard enclosure finish][or][white enclosure finish]**.

D. Energy storage modules must be factory installed in cabinets or racks. Each module or unit must be arranged to maintain required spacing and materials complying with UL 9540 and UL-9540A testing recommendations.

E. Front access: All serviceable subassemblies must be modular and capable of being replaced from the front of the cabinet. Side access for installation, service, repair, or maintenance of the system must not be required.

F. Cable entry: standard cable entry for the ESS must be through the enclosure bottom.

2.9 DATA ACQUISITION AND CONTROL

A. The ESS must include a monitoring and data acquisition system and must include, at a minimum, the following information in 15-minute intervals (unless otherwise noted):

1. Real-time ESS State of charge
2. System mode (charge, discharge, island, grid-tied etc.) and condition (normal, auto, manual, override, etc.)
3. System voltages, current, and power
4. Real-time connected generation source(s) power and connected load power consumption.
5. Enclosure Ambient temperature, hourly average at hourly intervals.
6. Energy and time remaining at current discharge or charge rate
7. Time until full charge at current recharge rate
8. Forecasted charge and discharge profile
9. Round-trip efficiency on daily, weekly, monthly, yearly basis
10. System fire protection and alarm condition
11. Notification when preventive maintenance is needed
12. System alarm and events:

    a. Major: system automatically disconnected due to over/under voltage, overcurrent or over temperature.

b. Minor: voltage imbalance, voltage sensing error, under-temperature, temperature imbalance, overprotection device activation, communication failure, regular maintenance required (i.e., perform balancing charge sequence)

B. Data must be saved locally for a minimum of **[(30) days][enter number of days]** and backed up off-site with a minimum of **[(36) months][enter number of months]** of data.

C. Data transmission must be transferred to off-site storage via one of the following connections:

1. Cellular connection
2. WAN Internet Connection **[coordinate with site specific conditions]**

D. Remote connection must be for monitoring purposes only. No system or device must require internet connection to function.

E. Local display must include visual indicator of ESS operation.

F. External remote monitoring using web-based service:

1. All data collected will be available in a web-based interface accessed via an internet connection.
2. The Contractor must ensure that data acquisition and monitoring solution complies with site specific US Government cybersecurity.
3. Access must be provided via secure login ID and password:

a. There will be no user-based fee to access the data
b. An unlimited number of users can access the data at the same time

4. The user interface must have the following functionality:

a. A site summary which provides data on the overall performance of the entire site
b. Detailed asset views on each individual piece of connected equipment
c. The ability to create time-data trends for all collected data.

2.10 FIRE PROTECTION AND FIRE ALARM SYSTEMS

A. The ESS must include recommended fire alarm and fire protection systems for installation locations.

B. Fire Protection System design must consider that ESS will be unattended at most times.

C. Provide visual and audible alarm when a safety hazard exists.

2.11 SOURCE QUALITY CONTROL

A. Factory end of line tests before shipment:

1. Factory test ESS and other system components and accessories manufactured specifically for this Project. Perform tests at rated power and for modes of operations in this specification.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before ESS installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes, and locations, and electrical to verify actual locations, sizes and other conditions affecting performance, maintenance, and operations.

1. Final ESS locations indicated on Drawings are approximate. Determine exact locations before roughing-in for electrical connections.

B. Provide required clearances and clear installation area of flammable vegetation. Maintain adequate setback to other structures, vegetation, and other flammable materials.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. The ESS must be provided with foundations and structures. All design must be in accordance with local project area seismic design requirements and as specified in the specifications for this project.

B. Install equipment in accordance with manufacturer's installation instructions and recommendations including required environmental conditions to maintain warranty and minimize system degradation.

C. ESS location must be above the **[insert year]** flood plain and surge levels and must be elevated higher than any pull vaults and conduit not sloped toward any ESS electrical component to prevent equipment flooding.

3.3 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section **[260518 "Low-Voltage Electrical Power Conductors and Cables."]**

3.4 IDENTIFICATION

A. ESS signs must be clearly printed in English and in local language.

B. Identify components according to Division 26 Section on Identification for Electrical Systems and include the following:

1. Identification in accordance with OBO Electrical Code, OBO Residential Code and OBO Fire Code referenced sections.
2. ESS electrical equipment and components must have markings that identify the manufacturer, size, type, rated input and output voltages, hazard warnings, frequency, number of phases (AC only), rating in kW or kVA, available fault current at ESS output terminals, maximum output and input current at terminals, maximum output and input voltage at terminals, and utility interactive capability.
3. Posted instructions for tasks that site staff may need to perform, such as system shutdown during an emergency.
4. Clearly label all disconnects, indicating whether in the open (OFF) or closed (ON) position, the operating system voltage, available fault current, current, and system rating.
5. Provide a disconnect or remote-controlled disconnect outside the building at a readily accessible location that is labeled “EMERGENCY DISCONNECT. Marking must include: (1) Nominal battery voltage (2) Available fault current (available from manufacturer) (3) Arc-flash label (4) Date short-circuit current calculation performed.
6. Arc flash labels, per NFPA-70E.
7. Identification and location of each power source on a permanent plaque or directory. The plaque or directory must indicate the location of each power source disconnecting means and be grouped with other plaques or directories for other power sources.

C. Equipment markings must be permanent and must withstand the environmental conditions in which the equipment is installed. Provide “UV rated” for outdoor labels, or on an embossed steel placard, designed for outdoor use and fastened with adhesive and rivets.

D. Markings must be visible or easily accessible during and after installation. The Contractor must be responsible for all field-applied markings as required by local, state, and federal codes.

3.5 FIELD QUALITY CONTROL AND START-UP

A. Provide the services of a qualified and certified factory-trained manufacturer’s representative for startup of the equipment specified under this section. The manufacturer’s representative must provide technical assistance to the contractor in general installation of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The manufacturer’s representative must provide inspection of the final installation, perform functional testing, and startup the ESS.

C. Startup acceptance test must be witnessed by the US Government representative. Provide notification to Project Director/COR within 30 calendar days of scheduled test. Contractor must be prepared at any time during this process to provide access to all portions of installation and must remedy any portion of system that is not in compliance with this specification, which does

not perform to manufacturer's operating specifications, or that fails to operate due to poor workmanship.

D. Ensure there is written permission from local utility company for interconnection of the ESS with the utility grid. Local utility company may require that representative of the local utility be onsite during initial interconnection; Contractor must accommodate this requirement, if stated by utility.

E. Functional Testing must include the following, in addition to all tests required by manufacturer:

1. Pre-startup inspection of the ESS system.
2. Test in accordance with the approved operating scenarios.
3. Verify and test system alarms.
4. Test ESS with all power generating sources and loads as applicable.

F. Provide photo record of installation and major components, including ESS, MCS, and all display screens. Include photos showing connections within all installed enclosures. Provide electronic copies of photo record on compact disc and hard copy of the photo record (with labels for each photo) in Operation and Maintenance Manual identified in Article on SUBMITTALS.

3.6 COMMISSIONING

A. Third Party Commissioning Agent: Engage electrically qualified and factory approved third-party certified commissioning agent to inspect, field test, and document performance of components and equipment after installation. Commissioning agent must prepare written test results in report.

B. All test instruments must be identified in Report and listed by manufacturer, model number, serial number, date of calibration, and calibration authority. All test instruments must have been calibrated within past year. Test instruments must have attached calibration sticker that is traceable to NIST.

C. Contractor must obtain written commissioning procedures document. Procedure entries must include date; time; person taking data; recorded value of data; indication if recorded value is out of range of system and/or equipment tolerance. Each page of the procedures must have test name; equipment tested; location; date; time; person performing test; model number of equipment; serial number of equipment; manufacturer; tolerance ranges of equipment tested for reference.

D. Commissioning Agent must keep Commissioning Issues Log and include it as appendix to Report. Log must include, but not be limited to issue description; log tracking number; date; time; person investing issue; action taken; person acting; date of closure of issue. Include copy of Commissioning Issues Log in written procedures to Contractor.

E. Perform the following field tests and inspections, in addition to manufacturer recommended tests and inspections, as follows for test report:

1. Test insulation resistance and continuity for each DC circuits, AC feeders, grounding including ground fault protection, and control circuits. Disconnect all sensitive electronic equipment prior to testing. Visually and physically inspect all cabling, connections, and

conduits. Verify color coding of conductors per OBO Electrical Code. Verify proper torque of termination connections with calibrated torque wrench.

2. Test ground fault protection of ESS (where required).
3. State of Health verification via coulomb counting.
4. Test proper operation of ESS for all operating scenarios. Set output voltage, as necessary. Verify that all local utility notifications and requirements have been incorporated.
5. Verify operation of all disconnect switches and proper sizing of all overcurrent protection devices (OCPD) in accordance with Division 26 Sections on enclosed switches and circuit breakers and on panelboards.
6. Verify that displays accurately represent output of ESS.
7. Power feedback controller: Monitor the utility power factor with the ESS functioning and with it disconnected. Identify the observed power factor. Verify the system modulates this power factor to not adversely affect utility billing.
8. Verify that remote data logging access has been established and is functioning. Provide all necessary data, IP addresses, login-ins, and passwords to post.

F. Contractor must remove and replace malfunctioning equipment. Retest ESS system as specified above.

3.7 DEMONSTRATION AND TRAINING

A. Comply with Division 01, Section 017905 *Demonstration and Training* for general requirements of demonstration and training documentation.

B. The manufacturer's representative must provide 'hands-on' training course for the US Government O&M personnel.

1. Schedule as follows:

   a. Two (2) four (4) hour training sessions equally divided into in-class training and in the field training, for a total of eight (8) hours.
   b. Training must be completed within one (1) calendar week.

2. Training must cover the following topics:

   a. Overall system description and theory of operation.
   b. Local displays and control interfaces.
   c. Operating scenarios.
   d. Automatic operation.
   e. Manual operation.
   f. Protective relaying.
   g. Recommended system checklists and log sheets.
   h. Recommended preventive maintenance and instructions to be performed by qualified staff.
   i. Hazards and failure modes – thermal runaway, off gassing, stranded energy
   j. Required ambient housing conditions to maintain required operating temperature range.

k. Thermal management and maintenance of liquid vs air cooled systems
l. Thermal propagation by battery chemistry
m. Instruction on balancing cycle - full discharge and slow charge technique to reset the state of charge algorithm
n. Instruction in and troubleshooting of errors in manufacturer's user interface.
o. Instruction on the operation of the assembly, and major components within the assembly.
p. Instruction on operation or maintenance that must be completed by factory authorized representative to maintain warranty and proper operation.
q. Fire protection and fire alarm system operation and procedures for the safe operation and actions during fire event or alarm.
r. Interactions with other systems.
s. Remote monitoring systems via online web services tools including

1) Login credentials and request for additional users
2) Menu options and available information
3) Review of graphical displays, data, and components
4) Interpretation of presented data
5) Optional displays and updates

C. The Contractor and Manufacturer's representative must coordinate with local fire officials on ESS setback requirements, first responder training, and posted instructions for shutoffs:

1. The Contractor must provide training to local firefighters covering ESS operation and how to shut it down in an emergency event and form a fire suppression plan. Training must cover the main risks of storage systems, including electric shock, thermal runaway, battery reignition, and stranded energy. Training must include fire suppression tactics, including minimum water and time requirements, thermal imaging camera, vehicle tilt / lift, and battery box piercing, as well as extrication and transport.
2. The Contractor must coordinate with the fire marshal to determine where to post the permanent instructions and required markings.

END OF SECTION 263313.11

SECTION 263313.12 – ENERGY STORAGE SYSTEMS (50kWh UP TO 600kWh)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the Energy Storage System (ESS) rated over 50 kWh and up to 600 kWh, and their associated internal components that create the entire system, including inverters, power conversion systems, microgrid interconnect devices, energy storage components, monitoring and control systems, miscellaneous electrical equipment, associated integral HVAC, Fire Protection and Fire Alarm Systems.

B. Related Sections include the following:

1. Section 230905 "Instrumentation and Controls for HVAC"
2. Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety"
3. Section 260518 "Low-Voltage Electrical Power Conductors and Cables"
4. Section 260525 "Grounding and Bonding for Electrical Systems"
5. Division 26 Section on raceways and boxes for conduits and outlet boxes
6. Section 260573 “Overcurrent Protective Device Coordination Study”
7. Section 260915 "Electrical Power Monitoring"
8. Division 26 Section on Enclosed Switches and Circuit Breakers
9. Division 26 Section on Fuses
10. Section 262214 "Low-Voltage Transformers"
11. Section 263105 "Solar Photovoltaic Systems"
12. Division 26 Section on “Vibration and Seismic Controls for Electrical Systems.”

1.2 REFERENCE STANDARDS

A. In addition to standards identified elsewhere in this Section and related Sections, conform to the following:

1. America National Standards Institute (ANSI)

   a. ANSI-C12.1 “Std. for Electricity Meters”

2. Institute of Electrical and Electronics Engineers (IEEE)

   a. IEEE-1547 “Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces”
   b. NESC “National Electrical Safety Code”

3. National Electrical Installation Standards (NEiS)

a. NECA-405 "Std for Installing & Commissioning Interconnected Generation Systems"
b. NECA-416 "Recommended Practice for Installing Energy Storage Systems"
c. NECA-417 "Std for Designing, Installing, Operating, & Maintaining Microgrids"
d. NECA-701-13 "Std for Energy Mgmt., Demand Response & Energy Solutions"

4. National Electrical Manufacturers Association (NEMA)

a. NEMA-250 "Enclosures for Electrical Equipment (1.0 kV Maximum)"

5. National Fire Protection Association (NFPA)

a. NFPA-68 "Std. on Explosion Protection by Deflagration Venting"
b. NFPA-69 "Std. on Explosion Prevention Systems"
c. NFPA-550 "Guide for the Evaluation of Fire Risk Assessments"
d. NFPA-551 "Guide for the Evaluation of Fire Risk assessments"
e. NFPA-855 "Std. for the Installation of Stationary ESSs"

6. Underwriters Laboratories, Inc. (UL)

a. UL-1642 "Std. for Lithium Batteries"
b. UL-1741 "UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources"
c. UL-1741SA "Standard for Safety Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources – Supplement A"
d. UL-1973 "Batteries for Use in Stationary and Motive Auxiliary Power Applications"
e. UL-9540 "Energy Storage Systems and Equipment" (ESS)
f. UL-9540A "Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems"

7. OBO Electrical Code (NFPA 70, "National Electrical Code" including amendments by OBO); reference Article 706 Energy Storage Systems, Article 705 Interconnected Electric Power Sources, and other Articles as applicable.
8. OBO Fire Code (International Fire Code including amendments by OBO); reference model code Section 1207 "Electrical Energy Storage Systems" and others as applicable.

1.3 DEFINITIONS

A. BESS: Battery Energy Storage System

B. BMS: Battery Monitoring System

C. EMS: Energy Management System

D. ESS: Energy Storage System

E. MCS: Microgrid Control System

F. NIST: National Institute of Standards and Technology

G. O&M: Operation and Maintenance

1.4 SUBMITTALS

A. Product Data: For Energy Storage System components. Include: Technical data on features, performance, electrical characteristics, ratings, weights, and finishes; rated capacities, operating characteristics, furnished specialties, and accessories; Factory published product specification data sheets; list of materials and components; UL listed data and certifications.

1. Energy Storage System components include but are not limited to:

a. Energy storage system cells, modules, units, stacks, membranes, and balance of system
b. Inverters, converters, and optimizers
c. Microgrid interconnect devices and controllers
d. Charge controllers
e. Energy management system and controllers
f. Switchboards, enclosed switches, panelboards, and their overcurrent protective devices
g. Fire protection and fire alarm system devices
h. Mounting equipment cabinets, racks, and containers
i. HVAC system components
j. Miscellaneous materials and equipment

B. Shop Drawings: Project specific for ESS and related equipment, include the following:

1. ESS description, including the following:

a. ESS chemistry, major component descriptions and their role to achieve required mode of operation.
b. Nameplate data, manufacturer, catalog numbers, and all major accessories used in the system.
c. System electrical characteristics: usable energy storage capacity; rated power; AC efficiency (including auxiliary loads); cycle life; and annual degradation factor.
d. Fire protection/suppression system and fire alarm description including plan for thermal runaway detection and mitigation.
e. Ambient temperature control system and environmental condition parameters.

2. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Site plan or floor plan showing the ESS location including dimensions, access, and auxiliary HVAC units.

b. ESS Cabinet/Container system dimensions including climate control units mounted on the side.
c. ESS assembly and equipment layouts.
d. Centerlines for all external conduit and grounding cable connections, and wall/floor/roof penetrations for auxiliary equipment.
e. Sections and elevations with height of components/container from floor level to top of components/containers highest non-moveable point.
f. Mounting system.
g. System weight, including subtotals by area.
h. Shipping center of gravity for each container and major equipment.
i. Construction staging and storage areas.
j. Owner requirements for all control and auxiliary equipment.
k. Fire protection and fire alarm system layouts.

3. Structural Certification: Certification by licensed structural engineer demonstrating ability of a structure to support all loads required for the ESS.
4. Electrical studies and schematic diagrams, include the following:

a. One-line diagram between major ESS components and interconnection to electrical distribution, including identification of DC versus AC-coupling.
b. Control wiring diagrams, with cross reference for checking and verifying all the control circuit and wiring diagrams, along with the terminal designations for termination of the field wiring of all equipment.
c. Communication and control diagrams.
d. Electrical studies to determine control response and settings, including load flow analysis, short circuit coordination, ampacity, and arc flash analysis in coordination with Section 260573 Overcurrent Protective Device (OCPD) Study.

5. ESS component equipment covered by other specification sections must comply with submittal requirements of the relevant specification section (i.e.: panelboards, switchboards, HVAC equipment, fire protection, fire alarm, enclosed switches, etc.).

C. Certificates of compliance: Provide certificates of compliance for referenced standards, and reports for referenced testing standards.

D. Qualification Data:

1. Support services vendor: Identify vendor firm name and contact, location, distance from project, years, and servicing product line.

E. Factory Test reports: ESS component tests (ESS modules, racking system, inverters, converters, microgrid controllers, HVAC, Fire protection and alarm, etc.) and integrated system test. Submit written test reports including test procedures used, final results and compliance with requirements.

F. Field Test reports: Submit written test reports, include the following:

1. Functional test procedures used.

2. Final test results. Include all test results and demonstrate their comparison to and compliance with requirements.
3. Report must include results of all failed tests and corrective action taken to achieve test results that comply with requirements.

G. Commissioning Test reports: Submit written test reports, include the following:

1. Commissioning test procedures tailored to the storage chemistry and operational performance.
2. Final commissioning test results and Commissioning Issues Log described in part three of this specification.
3. Commissioning test report must include results of all failed tests and corrective action taken to achieve test results to comply with requirements.

H. Operation and Maintenance Manuals:

1. In addition to the items specified in Division 01, Section 017825 *Systems Manual and O&M Data* include the following ESS documentation:

a. ESS equipment and components: Include description of unit or system, recommended maximum depth of discharge (DoD) and degradation rate, and component parts. Give function, normal operating characteristics, and limiting conditions.
b. Provide approved engineering submittals. Include equipment sizing calculations.
c. Provide manufacturer's installation wiring diagrams and schematic diagrams.
d. Operating procedures: Include routine normal operating instructions and sequence of operations. Include regulation, control, stopping, shutdown, system balancing and maintenance (i.e., full discharge and slow charge) and emergency instruction.
e. Special or recommended operating procedures to minimize energy storage capacity degradation over time with respect to seasons, depth of charge/discharge, voltage, humidity, etc.
f. Maintenance requirements: Include required materials, routine procedures and guide for cleaning, troubleshooting, equipment isolation, lockout, tagout, and ESS adjusting, balancing, and checking instructions.

2. ESS Fire protection procedures and instructions for authorized personnel and local firefighting personnel.

I. Record Documents: As specified in Division 01, Section 017705 *Closeout Procedures.*

1. Final as-built drawings and information
2. Assembly and wiring diagrams
3. Installation and operation information
4. Training materials for the operation and maintenance (O&M)

1.5 QUALITY ASSURANCE

A. Qualifications

1. The manufacturer of the ESS must be a company specializing in the manufacture of ESS equipment and have at least five (5) continuous years of documented experience with their hardware in commercial applications in the field.
2. Installation personnel: submit evidence prior to work that persons performing the work herein have manufacturer approved training and qualified experience in ESS installation, design, and applicable safety procedures, and hold proper licenses where applicable.
3. Commissioning personnel: Provide qualifications including experience of certified personnel responsible for ESS startup and commissioning work.

B. Listing and labeling:

1. Electrical components, devices, and accessories must be listed and labeled in accordance with a qualified testing agency and marked for intended location and application.
2. Certificates of compliance: Provide certificates of compliance for referenced standards.
3. Applications and installations must comply with the requirements of the codes and standards listed in this Section. Where required, certified test reports substantiating the compliance must be submitted upon request.

C. Support Service Capability:

1. ESS manufacturer must maintain a call center for technical and emergency support for this system.
2. ESS manufacturer must provide authorized field service vendor with factory-trained personnel for startup, maintenance, and repair of ESS and related equipment.
3. Availability of Service personnel: Manufacturer must have worldwide service organization, with authorized factory-trained service personnel available to provide support remotely 24 hours a day, 7 days a week, 365 days a year, and ability for onsite service.
4. Availability of Spare Parts: Manufacturers must have worldwide component and system distributorships, with replacement parts available from manufacturer using their regularly available expediting delivery for receipt within 48 hours of request.

D. All materials supplied for this project must be new.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment must be handled and stored in accordance with manufacturer's instruction, and as required to prevent any damage to system components and electronics. One (1) copy of these instructions must be included with the equipment at time of shipment.

B. Prior to and during construction, provide secure storage onsite for all ESS materials.

C. If stored in areas subjected to weather, cover equipment to provide protection from weather, dirt, dust, corrosive substances, and physical damage.

D. Where systems are intended for use in classified areas, appropriate considerations must be taken in the delivery, storage, and handling of the equipment.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Temperatures:

   a. Annual ambient: **[enter site specific value]** deg C to **[enter site specific value]** deg C
   b. Record low temperature: **[enter site specific value]** deg C
   c. Record high temperature: **[enter site specific value]** deg C

2. Altitude: Derate as required if over **[enter site specific value]** meters above sea level
3. Relative humidity: **[enter site specific value]**
4. **[enter other site-specific conditions such as wind ratings, sand/dust, seismic activity, salt air, fog, marine corrosiveness, etc.]**

1.8 COORDINATION

A. Coordinate layout and installation of ESS with other construction, including conduit, piping, equipment, and adjacent obstructions and surfaces. Maintain required clearances for workspace and equipment access.

B. Coordinate size and locations of anchor-bolt inserts into concrete slabs.

C. Provide system technical coordination for utility interconnection agreements. Provide grid connection as required, and in location as designated by local utility company.

D. Coordinate electrical voltage (V), phase (Ø), and hertz (Hz) characteristics of ESS's output with electrical characteristics of local utility company, and with ESS’s input if bidirectional inverter is used.

1.9 WARRANTIES

A. Provide ESS extended (10) year manufacturer’s warranty (excluding energy storage modules) valid from the date of substantial completion.

B. Energy storage module(s) warranties: Extended (10) year warranty after the date of substantial completion. Battery pack must retain at least **[70 percent][enter other percent nominal capacity]** of nominal energy capacity for the earlier of either (10) years after commissioning or after a minimum energy throughput of **[insert cumulative throughput]** kWh energy.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. The US Government must retain all rights to software and passwords used for this project.

B. Contractor must provide a copy of the manufacturer's standard software and end-user license agreement (EULA) for review and approval as condition of this contract. Such license must grant use of all programs and application software to the US Government as defined by manufacturer's license agreement but must protect manufacturer's rights to disclosure of Trade Secrets contained within such software. The Contractor must obtain a signed copy of the manufacturer's software and firmware licensing agreement prior to purchase.

C. The licensing agreement must not preclude use of software by individuals under contract to the US Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to the US Government will be restricted to use on the US Government's computers and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation must become the property of the US Government.

1.11 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date, provide 12 months full maintenance by authorized field service vendor with factory-trained certified personnel. Provide system maintenance service with adjusting as required for proper operation based on manufacturer's recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. Provide parts and supplies same as those used in the manufacture and installation of original equipment. In addition to the initial year of maintenance service, provide a proposal for a five-year period with (5) one-year, annually renewable periods, starting from end of initial maintenance period. The option year proposal must be submitted **[120]** days prior to the end of the maintenance contract period.

B. Maintenance service must include preventive maintenance, repair, or replacement of worn or defective components, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks must also align with the manufacturer's recommended checklists as required in Division 01, Section 017825 *Systems Manual and O&M Data.* Provide complete maintenance records inclusive of scheduling to the US Government for inclusion in the Computerized Maintenance Management System CMMS.

C. The Maintenance Service must include an annual report to US Government verifying that the ESS is performing as intended per the battery storage strategy and manufacturer recommendations. The report must include:

1. Use case performance.
2. Battery outages with root cause summary/failure modes and effects analysis, start and end time periods.
3. Summary of all O&M operations; repair and replacements.
4. Summary of safety incidents, causes, and resolutions.
5. Contractor must perform all required maintenance to the ESS and BMS to ensure that the monthly demand reduction is provided.

6. In addition to required demonstration and training in PART 3 of this specification, the Contractor must provide an additional eight (8) hours O&M training session to the US Government O&M personnel prior to the completion of the initial 12 months of maintenance service. Training must comply with PART 3 and cover issues and resolution encountered during the initial 12 months of maintenance service by service maintenance staff and US Government O&M.
7. Perform updates to the battery management system dispatch strategy if required due to rate tariff or major site load profile changes.
8. Ensure that all system firmware is up to date and meets US Government cybersecurity requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Kronus Engineering
2. ESS
3. Fluence
4. LG Energy Solution Vertech
5. Sungrid Solutions
6. **[other manufacturer]**

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if accepted by the Project Contracting officer Representative (COR) and Engineer **[(10)]** calendar days prior to bid date. Submit alternate manufacturer for review to allow **[(14)]** calendar days for review with sufficient documentation demonstrating compliance with project requirements.

C. The design drawings must include details, equipment dimensions, and space requirements based on the **[first listed acceptable manufacturer]**. If the Contractor selects a different equipment supplier, some redesign including locations of conduits, terminations, and space clearance may be required. Additional costs incurred for these changes must be borne by the Contractor.

2.2 GENERAL REQUIREMENTS FOR ESS

A. ESS must be listed for the intended use in accordance with OBO-ICS NEC Chapters 1 and 7.

B. ESS must be UL-9540 listed and tested in accordance with UL-9540A.

C. Provide Nameplate, mimic bus, arc flash rating, and System drawing to be located on the doors of containers, equipment, or cabinets.

1. The System must have a **[enter kW rating]** kW-AC rating and **[enter kWh rating]** kWh-AC usable rating.
2. The System AC Voltage must be **[enter system voltage]** volts.

D. Exposed Conduit: All exterior exposed conduits must be galvanized rigid steel (RMC) with threaded fittings.

E. ESS Output: ESS must match local utility company exactly in voltage, phase, and frequency to allow it to be grid-tied in accordance with local utility company's safety and power quality requirements. Coordinate all requirements with local utility company. Refer to Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety" for additional metering requirements.

F. The ESS must contain protective relays, circuit breakers, or fuses which self-protect the ESS in the case of internal electrical faults. Set and adjust circuit protection devices according to a short circuit and coordination study.

G. A visible disconnect will be installed that isolate the ESS from utility interconnection, complying with local utility requirements.

H. Grounding: Contractor must provide grounding system for personnel protection for step and touch potential complying with IEEE-Std-80. The system also must be adequate for the detection and clearing of ground faults within the ESS. The system should be grounded in all anticipated operating modes (e.g., grid-tied, and islanded).

I. The ESS must be capable of grid forming for microgrid islanding applications, complying with all local utility requirements, and compatible with other power generating sources.

J. Seismic Performance: ESS must withstand effects of earthquake motions determined according to ASCE/SEI 7.

1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operation after the seismic event.”

2.3 PERFORMANCE REQUIREMENTS

A. Integrate the ESS with the following power generation systems and **[existing]** power distribution system:

1. **[enter kW nameplate capacity]** Photovoltaic system(s)
2. **[enter kW nameplate capacity]** Generator(s)
3. **[enter kW nameplate capacity]** Wind Turbine system(s)
4. **[enter kW nameplate capacity]** Fuel Cell(s)
5. **[enter other power generation]**

B. The ESS must operate for the following scenario(s):

1. Demand control: The ESS must provide grid electricity usage and demand/peak shaving to limit demand (kW) to programmed setting.

   a. **[Anticipated][Current]** site monthly peak demand is **[insert monthly peak kW demand]**, and average load is **[insert average demand in kW]**. Limit grid demand by **[specify the required demand reduction in kW]**. The ESS must have a method for forecasting the peak load and automatically dispatching the battery or scheduling the charge/discharge in advance.
   b. Time of Use Charge Reduction: Integrate the ESS to discharge during on-peak or mid-peak hours in accordance with the site's rate tariff and the resiliency requirements of the site.
   c. ESS must maintain a round-trip efficiency greater than **[70][90]** percent AC-in to AC-out (confirmable by operation over a single round-trip cycle from 0 percent state of charge to 100 percent, and back to 0 percent at standard conditions specified by the manufacturer), including thermal losses and auxiliary loads, over 10 years.
   d. Annual ESS savings will be generated by discharging the battery during on-peak periods, as well as during peak billing demand periods.
   e. Grid stability by ramping up and down ESS output in response to utility grid frequency.

2. Grid outage: The ESS must support critical loads in microgrid operation in the event of a grid outage.

   a. Install a microgrid control system **[and modify existing]** electrical distribution and automatic transfer schemes as necessary to provide electricity to the campus upon grid failure. The Contractor must include the creation of a critical power circuit, including re-wiring of the critical loads and installation of critical power switchgear, in the scope of work (SOW).
   b. The ESS must support the critical loads **[as indicated on drawings]**.
   c. The ESS must perform anti-islanding sequence and grid forming operation to enable microgrid mode with "black start" capability.
   d. The ESS controller must disconnect load to prevent overload or over discharge and must manage charge/discharge function when utility grid is re-established.
   e. Consider the following site-specific parameters in the system design:

      1) [Specify site-specific operating conditions: provide electric load interval data, required ramp rates for existing generators, additional information on the types of loads to be served and required modes of operation. Provide detail on existing control and monitoring systems.]
      2) Configure ESS to provide seamless transition between utility power and microgrid.
      3) Optimize system to minimize generator use to conserve fuel.

C. Interval Testing:

1. The ESS must be demonstrated to perform on a recurring basis to ensure the Agency's desired site resilience and energy assurance. This interval testing frequency must occur approximately every twelve (12) months following final acceptance to ensure provision of power to the site in the event of a utility-provided power outage or interruption. This activity requires pre-coordination with the local servicing utility in accordance with the approved interconnection agreement, and that coordination must be led by the Contractor in consultation with the Agency's Facilities Manager (FM).
2. This periodic demonstration must stagger months, seasons, load, time of day, and weather variabilities, but must be conducted at least every twelve (12) months.
3. Periodic testing will be the responsibility of **[specify entity responsible for O&M]**.
4. In the event of an actual utility power interruption exceeding **[insert specified duration]**, the ESS's performance will satisfy this requested demonstration, thereby resetting the interval to twelve (12) months prior to the next required demonstration.
5. Any deficiencies or anomalies beyond expected design parameters, in an actual event or demonstration event, are to be reported to the Agency within twenty-four (24) hours in writing, with recommended remediation or corrective steps to prevent recurrence.

2.4 ENERGY STORAGE COMPONENTS

A. Energy storage components must consist of **[lithium-ion batteries][nickel-cadmium batteries][nickel metal hydride batteries][flow batteries][lead-acid][other battery or electrochemical ESS technology]**.

B. Energy storage systems may be individual cells, and supplied as modules comprised of cells, or as group of modules combined into units. Several units may be combined to make up the balance of the system. Cells, modules, and units must be fully enclosed in listed assembly for the intended purpose. Individual battery trays and/or racks must not be permitted.

C. Energy storage systems comprised of battery systems must be UL-1973 listed for the intended use.

D. A battery management system must monitor and balance cell voltages, currents, and temperatures within the manufacturer's specification. The battery management system must be part of the ESS component UL listing. The BMS must the charging and discharging of the equipment. The BMS must be field programmable via a laptop and viewing/editing on a locally hosted web browser. Programming instructions and setpoints must be shared with Agency staff.

E. [The battery management system charge controller must have Maximum Power Point Tracking (MPPT) for DC coupled PV systems.]

F. The cells, modules, units, and installation must be supplied with all required and/or manufacturer recommended accessories.

G. ESS DC voltage must not exceed **[1000Vdc][1500Vdc][other DC voltage].**

H. The use of vented batteries must not be permitted.

2.5 POWER CONVERSION SYSTEMS

A. Power Conversion Systems (PCS) must be UL-1741 or UL-1741SA listed for the intended use.

B. PCS output must match local utility company frequency and voltage when grid tied to local utility or in combination with **[generator operation][microgrid control system]** where applicable.

C. PCS output connections and operation must comply with all local utility company requirements.

D. PCS must have the following electrical characteristics:

1. Efficiency: minimum 95 percent
2. Frequency: 50/60 Hz
3. AC Voltage range: matching utility voltage
4. DC Voltage range: matching energy storage DC voltage
5. THD: < 3 percent
6. Power factor: -1 to +1

E. The PCS must have the following features to operate in the required performance scenario(s):

1. Perform grid-tie and grid-forming operation with “black start” capability and seamless transfer.
2. Bi-directional charge and discharge of the ESS with intelligent controls and interface with battery management system.
3. Complete automatic unattended operation including startup, synchronization, power disconnect, and parallel operation with the utility **[and generators]**. **[Where applicable, the system must also operate in parallel with: [photovoltaic systems,][generators,] [other site power production,] and utility]**.
4. Shutting down without damage when ESS output is outside tolerance parameters of inverter.
5. Automatic anti-islanding in conformance with referenced standards.
6. **[other features]**

2.6 MICROGRID CONTROL SYSTEM (MCS)

A. The MCS may be a separate component or combined with the ESS or inverter. The MCS must be one of the following: be listed, listed individual components assembled as a system, or designed under engineering supervision.

B. The MCS must include an energy management system (EMS), when an additional onsite generating source is present (i.e., solar or generators).

C. The MCS must have the following features to achieve the intended performance scenario(s):

1. Communicate with the ESS intelligent controls and monitor energy contribution from the **[Photovoltaic system,][generators,][grid,][other site power production].**
2. Monitor, log and report the energy consumption load profile.

3. The EMS must balance the power generation inputs, load outputs and signal controls to achieve the intended performance scenarios including grid services (such as peak demand shaving and energy arbitrage) and backup power to meet resiliency requirements. using an intelligent optimization algorithm.
4. Must autonomously initiate anti-islanding and grid forming sequence with battery power conversion system, generator controllers, or grid-forming inverters to operate in microgrid mode.
5. Ability to control the quantity and ratings of generation sources, utility, and output loads as indicated on drawings.
6. Communicate with, and directly control, connected generation sources including PV inverters, generator control panels, and battery converters. The MCS must be capable of coordinating the interaction between multiple power sources of similar or different types, manufacturers and technologies utilizing industry standard communication protocols.
7. Provide local and remote monitoring capability complying with this specification.
8. Be housed within the ESS or in separate enclosure complying with environmental conditions in this specification.
9. Include a programmable onsite interface to adjust the operating modes and threshold values.
10. Ability to log and export historical data from each connected generation source.

2.7 HEATING VENTILATION AND AIR CONDITIONING (HVAC)

A. The ESS must include a completely integrated HVAC system designed to always maintain component temperatures including heating, cooling, and relative humidity. Thermal conditioning systems must maintain ambient temperatures and humidity within warranty requirements and manufacturer recommendations.

2.8 ENCLOSURE

A. The ESS and associated equipment must be in a factory assembled climate-controlled enclosure that is rated for the site conditions.

B. The ESS, and associated equipment, must be provided in self-contained NEMA **[3R][4X]** enclosure(s) rated for the site conditions. ESS enclosures must be designed to be installed onto properly prepared pads/foundations.

C. Provide manufacturer **[standard enclosure finish][or][white enclosure finish]**.

D. ESS components and associated ancillary equipment must have working space clearances complying with OBO ICS NEC.

E. Energy storage modules or units must be rack mounted or installed in cabinets, per manufacturer recommendations inside factory enclosure or container. Each module or unit must be arranged to maintain required spacing and materials complying with UL-9540A testing recommendations and OBO Fire Code.

F. Front **[and rear]**access: All serviceable subassemblies must be modular and capable of being replaced from the front **[and rear]**of the cabinet. Side **[or rear]**access for installation, service, repair, or maintenance of the system must not be required.

G. Cable entry: standard cable entry for the ESS must be through the enclosure bottom.

2.9 DATA ACQUISITION AND CONTROL

A. The ESS must include a monitoring and data acquisition system and must include, at a minimum, the following information in 15-minute intervals (unless otherwise noted):

1. Real-time ESS State of charge.
2. System mode (charge, discharge, island, grid-tied etc.) and condition (normal, auto, manual, override, etc.).
3. System voltages, current, and power.
4. Real-time connected generation source(s) power and connected load power consumption.
5. Enclosure Ambient temperature, hourly average at hourly intervals.
6. Energy and time remaining at current discharge or charge rate.
7. Time until full charge at current recharge rate.
8. Forecasted charge and discharge profile.
9. Round-trip efficiency on daily, weekly, monthly, yearly basis.
10. System fire protection and alarm condition
11. Notification when preventive maintenance is needed.
12. System alarm and events:

    a. Major: system automatically disconnected due to over/under voltage, overcurrent or over temperature.
    b. Minor: voltage imbalance, voltage sensing error, under-temperature, temperature imbalance, overprotection device activation, communication failure, regular maintenance required (i.e., perform balancing charge sequence).

B. Data must be saved locally for a minimum of **[(30) days][enter number of days]** and backed up off-site with a minimum of **[(36) months][enter number of months]** of data.

C. Data transmission must be transferred to off-site storage via one of the following connections:

1. Cellular connection.
2. WAN Internet Connection **[coordinate with site specific conditions]**.

D. Remote connection must be for monitoring purposes only. No system or device must require internet connection to function.

E. Local display and control:

1. Local display must provide listed data monitoring in this specification.
2. Local control panel via interface or dedicated server must allow for local control and adjustments of setpoints and threshold values.

3. Local display may be visible without password protection. Local control must be password and user protected.
4. Local display must have touch screen interface.

F. Monitoring by Building Automation System (BAS):

1. The ESS must communicate with an external controller via MODBUS over TCP/IP.
2. The ESS must provide monitoring data and reporting to the BAS. The BAS must not have capability to modify or control the ESS remotely.

G. External remote monitoring using web-based service:

1. All data collected will be available in a web-based interface accessed via an internet connection.
2. The Contractor must ensure that data acquisition and monitoring solution complies with site specific US Government cybersecurity.
3. Access must be provided via secure login ID and password:

a. There will be no user-based fee to access the data.
b. An unlimited number of users can access the data at the same time.

4. The user interface must have the following functionality:

a. A site summary which provides data on the overall performance of the entire site
b. Detailed asset views on each individual piece of connected equipment
c. The ability to create time-data trends for all collected data.

2.10 FIRE PROTECTION AND FIRE ALARM SYSTEMS

A. The ESS must include an integrated fire protection and fire alarm system in accordance with UL-9540A test report. Fire protection system must be water-based suppression type system unless approved by OBO Fire.

B. The system must communicate with the compound Fire Alarm System.

C. Fire Protection System design must consider that ESS will be unattended at most times.

D. Provide visual and audible alarm when a safety hazard exists.

2.11 SOURCE QUALITY CONTROL

A. Factory end of line tests before shipment:

1. Factory test ESS and other system components and accessories manufactured specifically for this Project. Perform tests at rated power and for modes of operations in this specification.
2. All test results must be documented including failed tests.

3. Re-test all failed tests until successful test is achieved.
4. Factory testing must be witnessed by the US Government representative. Provide notification to Project Director/COR within 30 calendar days of scheduled test. US Government representative must perform factory inspection at that time as well.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before ESS installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes, and locations, and electrical to verify actual locations, sizes and other conditions affecting performance, maintenance, and operations.

1. Final ESS locations indicated on Drawings are approximate. Determine exact locations before roughing-in for electrical connections.

B. Provide required clearances and clear installation area of flammable vegetation. Maintain adequate setback to other structures, vegetation, and other flammable materials.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. The ESS must be provided with foundations and structures that are designed by or under the supervision of a qualified registered engineer. All design must be in accordance with local project area seismic design requirements and as specified in the specifications for this project.

B. Install equipment in accordance with manufacturer’s installation instructions and recommendations.

C. ESS location must be above the **[insert year]** flood plain and surge levels and must be elevated higher than any pull vaults and conduit not sloped toward any ESS electrical component to prevent equipment flooding. ESS must be located within a thermally conditioned enclosure.

3.3 CONNECTIONS

A. Ground equipment according to Section 260525 “Grounding and Bonding for Electrical Systems.”

B. Connect wiring according to Section **[260518 “Low-Voltage Electrical Power Conductors and Cables”][Division 26 Section on MV conductor and cables].**

C. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified

in UL-486A and UL-486B. Make a permanent mark on all joints, connectors, and terminals after they have been torqued to the proper value.

3.4 IDENTIFICATION

A. ESS signs must be clearly printed in English and in local language.

B. Identify components according to Division 26 Section on Identification for Electrical Systems and include the following:

1. Identification in accordance with OBO Electrical Code and OBO Fire Code referenced sections.
2. ESS electrical equipment and components must have clear/visible markings that identify the manufacturer, size, type, rated input and output voltages, hazard warnings, frequency, number of phases (AC only), rating in kW or kVA, available fault current at ESS output terminals, maximum output and input current at terminals, maximum output and input voltage at terminals, and utility interactive capability.
3. Posted instructions for tasks that site staff may need to perform, such as system shutdown during an emergency.
4. Clearly label all disconnects, indicating whether in the open (OFF) or closed (ON) position, the operating system voltage, available fault current, current, and system rating.
5. ESS disconnecting means must indicate whether ON or OFF and be marked “ENERGY STORAGE SYSTEM DISCONNECT.” Disconnecting means must also be clearly marked to indicate: (1) Nominal ESS voltage, (2) Available fault current, (3) Arc-flash label, (4) Date calculation performed.
6. Arc flash labels, per NFPA-70E.
7. Identification and location of each power source on a permanent plaque or directory. The plaque or directory must indicate the location of each power source disconnecting means and be grouped with other plaques or directories for other power sources.

C. Equipment markings must be permanent and must withstand the environmental conditions in which the equipment is installed. Provide “UV rated” for outdoor labels, or on an embossed steel placard, designed for outdoor use and fastened with adhesive and rivets.

D. Markings must be visible or easily accessible during and after installation. The Contractor must be responsible for all field-applied markings as required by local, state, and federal codes.

3.5 FIELD QUALITY CONTROL AND STARTUP

A. Provide the services of a qualified and certified factory-trained manufacturer’s representative for startup of the equipment specified under this section. The manufacturer’s representative must provide technical assistance to the contractor in general installation of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The manufacturer’s representative must provide inspection of the final installation, perform functional testing, and startup the ESS.

C. Startup acceptance test must be witnessed by the US Government representative. Provide notification to Project Director/COR within 30 calendar days of scheduled test. Contractor must be prepared at any time during this process to provide access to all portions of installation and must remedy any portion of system that is not in compliance with this specification, which does not perform to manufacturer's operating specifications, or that fails to operate due to poor workmanship.

D. Ensure there is written permission from local utility company for interconnection of the ESS with the utility grid. Local utility company may require that representative of the local utility be onsite during initial interconnection; Contractor must accommodate this requirement, if stated by utility.

E. Functional Testing must include the following, in addition to all tests required by manufacturer:

1. Pre-startup inspection of the ESS system.
2. Test in accordance with the approved operating scenarios.
3. Verify and test system alarms.
4. Test ESS with all power generating sources and loads as applicable.

F. Provide photo record of installation and major components, including ESS, MCS, and all display screens. Include photos showing connections within all installed enclosures. Provide electronic copies of photo record on compact disc and hard copy of the photo record (with labels for each photo) in Operation and Maintenance Manual identified in Article on SUBMITTALS.

3.6 COMMISSIONING

A. Third Party Commissioning Agent: Engage electrically qualified and factory approved third party certified commissioning agent to inspect, field test, and document performance of components and equipment after installation. Commissioning agent must prepare written test results in report.

B. All test instruments must be identified in Report and listed by manufacturer, model number, serial number, date of calibration, and calibration authority. All test instruments must have been calibrated within past year. Test instruments must have attached calibration sticker that is traceable to NIST.

C. Contractor must obtain written commissioning procedures document. Procedure entries must include date; time; person taking data; recorded value of data; indication if recorded value is out of range of system and/or equipment tolerance. Each page of the procedures must have test name; equipment tested; location; date; time; person performing test; model number of equipment; serial number of equipment; manufacturer; tolerance ranges of equipment tested for reference.

D. Commissioning Agent must keep Commissioning Issues Log and include it as appendix to Report. Log must include, but not be limited to issue description; log tracking number; date; time; person investing issue; action taken; person acting; date of closure of issue. Include copy of Commissioning Issues Log in written procedures to Contractor.

E. Perform the following field tests and inspections, in addition to manufacturer recommended tests and inspections, as follows for test report:

1. Test insulation resistance and continuity for each DC circuits, AC feeders, grounding including ground fault protection, and control circuits. Disconnect all sensitive electronic equipment prior to testing. Visually and physically inspect all cabling, connections, and conduits. Verify color coding of conductors per OBO Electrical Code. Verify proper torque of termination connections with calibrated torque wrench.
2. Test ground fault protection of ESS (where required).
3. State of Health verification via coulomb counting.
4. Test proper operation of ESS for all operating scenarios. Set output voltage, as necessary. Verify that all local utility notifications and requirements have been incorporated.
5. Verify operation of all disconnect switches and proper sizing of all overcurrent protection devices (OCPD) in accordance with Division 26 Sections on enclosed switches and circuit breakers and on panelboards.
6. Verify that displays accurately represent output of ESS.
7. Power feedback controller: Monitor the utility power factor with the ESS functioning and with it disconnected. Identify the observed power factor. Verify the system modulates this power factor to not adversely affect utility billing.
8. Verify that remote data logging access has been established and is functioning. Provide all necessary data, IP addresses, login-ins, and passwords to post.

F. Contractor must remove and replace malfunctioning equipment. Retest ESS system as specified above.

3.7 DEMONSTRATION AND TRAINING

A. Comply with Division 01, Section 017905 *Demonstration and Training* for general requirements of demonstration and training documentation.

B. The manufacturer's representative must provide 'hands-on' training course for the US Government O&M personnel.

1. Schedule as follows:

   a. Two (2) eight (8) hour training sessions equally divided into in-class training and in the field training, for a total of sixteen (16) hours.
   b. Training must be completed within two (2) calendar weeks.

2. Training must cover the following topics:

   a. Overall system description and theory of operation.
   b. Local displays and control interfaces.
   c. Operating scenarios.
   d. Automatic operation.
   e. Manual operation.
   f. Protective relaying.
   g. Recommended system checklists and log sheets.
   h. Recommended preventive maintenance and instructions to be performed by qualified staff.

i. Instruction on the operation of the assembly, and major components within the assembly.
j. Instruction on operation or maintenance that must be completed by factory authorized representative to maintain warranty and proper operation.
k. Fire protection and fire alarm system operation and procedures for the safe operation and actions during fire event or alarm.
l. Interactions with other systems.
m. Overview of relevant storage chemistry, internal thermal management system, and required ambient housing conditions to maintain required operating temperature range.
n. Identification of emergency disconnects.
o. Fire suppression system maintenance – pump and distribution system maintenance for dry standpipe systems.
p. Instruction on balancing cycle and state of charge tests to gauge state of health.
q. Hazards and failure modes, including thermal runaway, off gassing, and stranded energy.
r. Mitigation / response measures for electrolyte releases, overheated batteries and fires.
s. Instruction in liquid-cooled system maintenance, including pump and coolant inspection, leak detection, visual inspection, and verification of pressure and gauge accuracy.
t. Power conversion system inspection and calibration.

C. The Contractor and Manufacturer's representative must coordinate with local fire marshals on ESS setback requirements, first responder training, and posted instructions for shutoffs:

1. The Contractor must provide training to local firefighters covering ESS operation and how to shut it down in an emergency event and form a fire suppression plan. Training must cover the main risks of storage systems, including electric shock, thermal runaway, battery reignition, and stranded energy. Training must include fire suppression tactics, including minimum water and time requirements, thermal imaging camera, vehicle tilt / lift, and battery box piercing, as well as extrication and transport.
2. The Contractor must coordinate with the fire marshal to determine where to post the permanent instructions and required markings.

D. The Contractor must provide a minimum four (4) hour online training to US Government O&M personnel, Government IT personnel, and OBO representative of the remote monitoring systems via online web services tools. The training must be recorded and remain available for ongoing access to training. The training must include:

1. Login credentials and request for additional users
2. Menu options and available information.
3. Review of graphical displays, data, and components.
4. Interpretation of presented data.
5. Optional displays and updates.

END OF SECTION 263313.12

SECTION 263313.13 – ENERGY STORAGE SYSTEMS (OVER 600 kWh)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the Energy Storage System (ESS) rated over 600kWh and their associated internal components that create the entire system, including inverters, power conversion systems, microgrid interconnect devices, energy storage components, monitoring and control systems, miscellaneous electrical equipment, associated integral HVAC, Fire Protection and Fire Alarm Systems.

B. Related Sections include the following:

1. Section 230905 "Instrumentation and Controls for HVAC."
2. Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety."
3. Section 260518 "Low-Voltage Electrical Power Conductors and Cables."
4. Section 260525 "Grounding and Bonding for Electrical Systems."
5. Division 26 Section on raceways and boxes for conduits and outlet boxes.
6. Section 260573 “Overcurrent Protective Device Coordination Study.”
7. Section 260915 "Electrical Power Monitoring."
8. Division 26 Section on Enclosed Switches and Circuit Breakers.
9. Division 26 Section on Fuses.
10. Section 262214 "Low-Voltage Transformers."
11. Section 263105 "Solar Photovoltaic Systems."
12. Division 26 Section on “Vibration and Seismic Controls for Electrical Systems.”

1.2 REFERENCE STANDARDS

A. In addition to standards identified elsewhere in this Section and related Sections, conform to the following:

1. America National Standards Institute (ANSI)

   a. ANSI-C12.1 “Std. for Electricity Meters”

2. Institute of Electrical and Electronics Engineers (IEEE)

   a. IEEE-1547 “Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces”
   b. NESC “National Electrical Safety Code”

3. National Electrical Installation Standards (NEiS)

a. NECA-405 "Std for Installing & Commissioning Interconnected Generation Systems"
b. NECA-416 "Recommended Practice for Installing Energy Storage Systems"
c. NECA-417 "Std for Designing, Installing, Operating, & Maintaining Microgrids"
d. NECA-701-13 "Std for Energy Mgmt., Demand Response & Energy Solutions"

4. National Electrical Manufacturers Association (NEMA)

a. NEMA-250 "Enclosures for Electrical Equipment (1.0 kV Maximum)"

5. National Fire Protection Association (NFPA)

a. NFPA-68 "Std. on Explosion Protection by Deflagration Venting"
b. NFPA-69 "Std. on Explosion Prevention Systems"
c. NFPA-550 "Guide for the Evaluation of Fire Risk Assessments"
d. NFPA-551 "Guide for the Evaluation of Fire Risk assessments"
e. NFPA-855 "Std. for the Installation of Stationary Energy Storage Systems"

6. Underwriters Laboratories, Inc. (UL)

a. UL-1642 "Std. for safety for lithium batteries"
b. UL-1741 "UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources"
c. UL-1741SA "Standard for Safety Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources – Supplement A"
d. UL-1973 "Standard for batteries for use in stationary applications and Motive Auxiliary Power Applications"
e. UL-9540 "Energy Storage Systems and Equipment"
f. UL-9540A "Test method for evaluating thermal runaway fire propagation in battery energy storage systems"

7. OBO Electrical Code (NFPA 70, "National Electrical Code" including amendments by OBO); reference Article 706 Energy Storage Systems, Article 705 Interconnected Electric Power Sources, and other Articles as applicable.
8. OBO Fire Code (International Fire Code including amendments by OBO); reference model code Section 1207 "Electrical Energy Storage Systems" and others as applicable.

1.3 DEFINITIONS

A. BESS: Battery Energy Storage System

B. BMS: Battery Monitoring System

C. EMS: Energy Management System

D. ESS: Energy Storage System

E. MCS: Microgrid Control System

F. NIST: National Institute of Standards and Technology

G. O&M: Operation and Maintenance

1.4 SUBMITTALS

A. Product Data: For Energy Storage System components. Include: Technical data on features, performance, electrical characteristics, ratings, weights, and finishes; rated capacities, operating characteristics, furnished specialties, and accessories; Factory published product specification data sheets; list of materials and components; UL listed data and certifications.

1. Energy Storage System components include but are not limited to:

a. Energy storage system cells, modules, units, stacks, membranes, and balance of system
b. Inverters, converters, and optimizers
c. Microgrid interconnect devices and controllers
d. Charge controllers
e. Energy management system and controllers
f. Switchboards, enclosed switches, panelboards, and their overcurrent protective devices
g. Fire protection and fire alarm system devices
h. Mounting equipment cabinets, racks, and containers
i. HVAC system components
j. Miscellaneous materials and equipment

B. Shop Drawings: Project specific for ESS and related equipment, include the following:

1. ESS description, including the following:

a. ESS chemistry, major component descriptions and their role to achieve required mode of operation
b. Nameplate data, manufacturer, catalog numbers, and all major accessories used in the system
c. System electrical characteristics: usable energy storage capacity; rated power; AC efficiency (including auxiliary loads); cycle life; and annual degradation factor.
d. Fire protection/suppression system and fire alarm description including plan for thermal runaway detection and mitigation
e. Ambient temperature control system and environmental condition parameters

2. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Site plan or floor plan showing the ESS location including dimensions, access, and auxiliary HVAC units.

b. ESS Cabinet/Container system dimensions including climate control units mounted on the side.
c. ESS assembly and equipment layouts
d. Centerlines for all external conduit and grounding cable connections, and wall/floor/roof penetrations for auxiliary equipment.
e. Sections and elevations with height of components/container from floor level to top of components/containers highest non-moveable point.
f. Mounting system.
g. System weight, including subtotals by area
h. Shipping center of gravity for each container and major equipment
i. Construction staging and storage areas.
j. Owner requirements for all control and auxiliary equipment
k. Fire protection and fire alarm system layouts

3. Structural Certification: Certification by licensed structural engineer demonstrating ability of a structure to support all loads required for the ESS.
4. Electrical studies and schematic diagrams, include the following:

a. One-line diagram between major ESS components and interconnection to electrical distribution, including identification of DC versus AC-coupling.
b. Control wiring diagrams, with cross reference for checking and verifying all the control circuit and wiring diagrams, along with the terminal designations for termination of the field wiring of all equipment.
c. Communication and control diagrams.
d. Electrical studies to determine control response and settings, including load flow analysis, short circuit coordination, ampacity, and arc flash analysis in coordination with Section 260573 Overcurrent Protective Device (OCPD) Study

5. ESS component equipment covered by other specification sections must comply with submittal requirements of the relevant specification section (i.e.: panelboards, switchboards, HVAC equipment, fire protection, fire alarm, enclosed switches, etc.).

C. Certificates of compliance: Provide certificates of compliance for referenced standards, reports for referenced testing standards, and hazard mitigation analysis reports.

D. Qualification Data:

1. Support services vendor: Identify vendor firm name and contact, location, distance from project, years, and servicing product line.

E. Factory Test reports: ESS component tests (ESS modules, racking system, inverters, converters, microgrid controllers, HVAC, Fire protection and alarm, etc.) and integrated system test. Submit written test reports including test procedures used, final results and compliance with requirements.

F. Field Test reports: Submit written test reports, include the following:

1. Functional test procedures used.

2. Final test results. Include all test results and demonstrate their comparison to and compliance with requirements.
3. Report must include results of all failed tests and corrective action taken to achieve test results that comply with requirements.

G. Commissioning Test reports: Submit written test reports, include the following:

1. Commissioning test procedures tailored to the storage chemistry and operational performance.
2. Final commissioning test results and Commissioning Issues Log described in part three of this specification.
3. Commissioning test report must include results of all failed tests and corrective action taken to achieve test results to comply with requirements.

H. Operation and Maintenance Manuals:

1. In addition to the items specified in Division 01, Section 017825 *Systems Manual and O&M Data* include the following ESS documentation:

a. ESS equipment and components: Include description of unit or system, recommended maximum depth of discharge (DoD) and degradation rate, and component parts. Give function, normal operating characteristics, and limiting conditions.
b. Provide approved engineering submittals. Include equipment sizing calculations.
c. Provide manufacturer's installation wiring diagrams and schematic diagrams.
d. Operating procedures: Include routine normal operating instructions and sequence of operations. Include regulation, control, stopping, shutdown, system balancing and maintenance (i.e., full discharge and slow charge) and emergency instruction.
e. Special or recommended operating procedures to minimize energy storage capacity degradation over time with respect to seasons, depth of charge/discharge, voltage, humidity, etc.
f. Maintenance requirements: Include required materials, routine procedures and guide for cleaning, troubleshooting, equipment isolation, lockout, tagout, and ESS adjusting, balancing, and checking instructions.

2. ESS Fire protection procedures and instructions for authorized personnel and local firefighting personnel.

I. Record Documents: As specified in Division 01, Section 017705 *Closeout Procedures*.

1. Final as-built drawings and information
2. Assembly and wiring diagrams
3. Installation and operation information
4. Training materials for the operation and maintenance (O&M)

1.5 QUALITY ASSURANCE

A. Qualifications

1. The manufacturer of the ESS must be a company specializing in the manufacture of ESS equipment and have at least five (5) years of documented continuous experience with their hardware in commercial applications in the field.
2. Installation personnel: submit evidence prior to work that persons performing the work herein have manufacturer approved training and qualified experience in ESS installation, design, and applicable safety procedures, and hold proper licenses where applicable.
3. Commissioning personnel: Provide qualifications including experience of certified personnel responsible for ESS startup and commissioning work.

B. Listing and labeling:

1. Electrical components, devices, and accessories must be listed and labeled in accordance with a qualified testing agency and marked for intended location and application.
2. Certificates of compliance: Provide certificates of compliance for referenced standards.
3. Applications and installations must comply with the requirements of the codes and standards listed in this Section. Where required, certified test reports substantiating the compliance must be submitted upon request.

C. Support Service Capability:

1. ESS manufacturer must maintain a call center for technical and emergency support for this system.
2. ESS manufacturer must provide authorized field service vendor with factory-trained personnel for startup, maintenance, and repair of ESS and related equipment.
3. Availability of Service personnel: Manufacturer must have worldwide service organization, with authorized factory-trained service personnel available to provide support remotely 24 hours a day, 7 days a week, 365 days a year, and ability for onsite service.
4. Availability of Spare Parts: Manufacturers must have worldwide component and system distributorships, with replacement parts available from manufacturer using their regularly available expediting delivery for receipt within 48hours of request.

D. All materials supplied for this project must be new.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment must be handled and stored in accordance with manufacturer's instruction, and as required to prevent any damage to system components and electronics. One (1) copy of these instructions must be included with the equipment at time of shipment.

B. Prior to and during construction, provide secure storage onsite for all ESS materials.

C. If stored in areas subjected to weather, cover equipment to provide protection from weather, dirt, dust, corrosive substances, and physical damage.

D. Where systems are intended for use in classified areas, appropriate considerations must be taken in the delivery, storage, and handling of the equipment.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Temperatures:

   a. Annual ambient: **[enter site specific value]** deg C to **[enter site specific value]** deg C
   b. Record low temperature: **[enter site specific value]** deg C
   c. Record high temperature: **[enter site specific value]** deg C

2. Altitude: Derate as required if over **[enter site specific value]** meters above sea level
3. Relative humidity: **[enter site specific value]**
4. **[enter other site-specific conditions such as wind ratings, sand/dust, seismic activity, salt air, fog, marine corrosiveness, etc.]**

1.8 COORDINATION

A. Coordinate layout and installation of ESS with other construction, including conduit, piping, equipment, and adjacent obstructions and surfaces. Maintain required clearances for workspace and equipment access.

B. Coordinate size and locations of anchor-bolt inserts into concrete slabs.

C. Provide system technical coordination for utility interconnection agreements. Provide grid connection as required, and in location as designated by local utility company.

D. Coordinate electrical voltage (V), phase (Ø), and hertz (Hz) characteristics of ESS's output with electrical characteristics of local utility company, and with ESS’s input if bidirectional inverter is used.

1.9 WARRANTIES

A. Provide ESS extended (10) year manufacturer’s warranty (excluding energy storage modules) valid from the date of substantial completion.

B. Energy storage module(s) warranties: Extended (10) year warranty after the date of substantial completion. Battery pack must retain at least **[70 percent] [enter other percent nominal capacity]** of nominal energy capacity for the earlier of either (10) years after commissioning or after a minimum energy throughput of **[insert cumulative throughput]** kWh energy.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. The US Government must retain all rights to software and passwords used for this project.

B. Contractor must provide a copy of the manufacturer's standard software and end-user license agreement (EULA) for review and approval as condition of this contract. Such license must grant use of all programs and application software to the US Government as defined by manufacturer's license agreement but must protect manufacturer's rights to disclosure of Trade Secrets contained within such software. The Contractor must obtain a signed copy of the manufacturer's software and firmware licensing agreement prior to purchase.

C. The licensing agreement must not preclude use of software by individuals under contract to the US Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to the US Government will be restricted to use on the US Government's computers and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation must become the property of the US Government.

1.11 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date, provide 12 months full maintenance by authorized field service vendor with factory-trained certified personnel. Provide system maintenance service with adjusting as required for proper operation based on Original Equipment Manufacturer's (OEM) recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. Provide parts and supplies same as those used in the manufacture and installation of original equipment. In addition to the initial year of maintenance service, provide a proposal for a five-year period with (5) one-year, annually renewable periods, starting from end of initial maintenance period. The option year proposal must be submitted **[120]** days prior to the end of the maintenance contract period.

B. Maintenance service must include preventive maintenance, repair, or replacement of worn or defective components, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks must also align with the manufacturer's recommended checklists as required in Division 01, Section 017825 *Systems Manual and O&M Data*. Provide complete maintenance records inclusive of scheduling to the US Government for inclusion in the Computerized Maintenance Management System (CMMS).

C. The Maintenance Service must include an annual report to US Government verifying that the ESS is performing as intended per the battery storage strategy and manufacturer recommendations. The report must include:

1. Use case performance.
2. Battery outages with root cause summary/failure modes and effects analysis, start and end time periods.
3. Summary of all O&M operations; repair and replacements.
4. Summary of safety incidents, causes and resolutions.
5. Contractor must perform all required maintenance to the ESS and BMS to ensure that the monthly demand reduction is provided.

6. In addition to required demonstration and training in PART 3 of this specification, the Contractor must provide an additional eight (8) hours O&M training session to the US Government O&M personnel prior to the completion of the initial 12 months of maintenance service. Training must comply with PART 3 and cover issues and resolution encountered during the initial 12 months of maintenance service by service maintenance staff and US Government O&M.
7. Perform updates to the battery management system dispatch strategy if required due to rate tariff or major site load profile changes.
8. Ensure that all system firmware is up to date and meets US Government cybersecurity requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Kronus Engineering
2. ESS
3. Fluence
4. LG Energy Solution Vertech
5. Powin
6. Sungrid Solutions
7. Tesla
8. **[other manufacturer]**

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if accepted by the Project Contracting Officer Representative (COR) and Engineer **[(10)]** calendar days prior to bid date. Submit alternate manufacturer for review to allow **[(14)]** calendar days for review with sufficient documentation demonstrating compliance with project requirements.

C. The design drawings must include details, equipment dimensions, and space requirements based on the **[first listed acceptable manufacturer]**. If the Contractor selects a different equipment supplier, some redesign including locations of conduits, terminations, and space clearance may be required. Additional costs incurred for these changes must be borne by the Contractor.

2.2 GENERAL REQUIREMENTS FOR ESS

A. ESS must be listed for the intended use in accordance with OBO-ICS NEC Chapters 1 and 7.

B. ESS must be UL-9540 listed and tested in accordance with UL-9540A.

C. Hazard Mitigation Analysis per OBO-IFC-1207 and NFPA-855 must be conducted, and report provided for OBO Fire review. The hazard mitigation analysis must consider the fire and explosive hazards and risks, failure model and effects analysis and identify mitigation strategies implemented including detailed system operation and requirements.

D. Provide Nameplate, mimic bus, arc flash rating, and System drawing to be located on the doors of containers, equipment, or cabinets.

1. The System must have a **[enter kW rating]** kW-AC rating and **[enter kWh rating]** kWh-AC usable rating.
2. The System AC Voltage must be **[enter system voltage]** volts.

E. Exposed Conduit: All exterior exposed conduits must be galvanized rigid steel (RMC) with threaded fittings.

F. ESS Output: ESS must match local utility company exactly in voltage, phase, and frequency to allow it to be grid-tied in accordance with local utility company's safety and power quality requirements. Coordinate all requirements with local utility company. Refer to Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety" for additional metering requirements.

G. The ESS must contain protective relays, circuit breakers, or fuses which self-protect the ESS in the case of internal electrical faults. Set and adjust circuit protection devices according to a short circuit and coordination study.

H. A visible disconnect will be installed that isolate the ESS from utility interconnection, complying with local utility requirements.

I. Grounding: Contractor must provide grounding system for personnel protection for step and touch potential complying with IEEE-Std-80. The system also must be adequate for the detection and clearing of ground faults within the ESS. The system should be grounded in all anticipated operating modes (e.g., grid-tied, and islanded).

J. The ESS must be capable of grid forming for microgrid islanding applications, complying with all local utility requirements, and compatible with other power generating sources.

K. Seismic Performance: ESS must withstand effects of earthquake motions determined according to ASCE/SEI 7.

1. The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operation after the seismic event.”

2.3 PERFORMANCE REQUIREMENTS

A. Integrate the ESS with the following power generation systems and **[existing]** power distribution system:

1. **[enter kW nameplate capacity]** Photovoltaic system(s)
2. **[enter kW nameplate capacity]** Generator(s)
3. **[enter kW nameplate capacity]** Wind Turbine system(s)
4. **[enter kW nameplate capacity]** Fuel Cell(s)
5. **[enter other power generation]**

B. The ESS must operate for the following scenario(s):

1. Demand control: The ESS must provide grid electricity usage and demand/peak shaving to limit demand (kW) to programmed setting.

    a. **[Anticipated] [Current]** site monthly peak demand is **[insert monthly peak kW demand]**, and average load is **[insert average demand in kW]**. Limit grid demand by **[specify the required demand reduction in kW]**. The ESS must have a method for forecasting the peak load and automatically dispatching the battery or scheduling the charge/discharge in advance.
    b. Time of Use Charge Reduction: Integrate the ESS to discharge during on-peak or mid-peak hours in accordance with the site's rate tariff and the resiliency requirements of the site.
    c. ESS must maintain a round-trip efficiency greater than **[70][90]** percent AC-in to AC-out (confirmable by operation over a single round-trip cycle from 0% state of charge to 100 percent, and back to 0 percent at standard conditions specified by the manufacturer), including thermal losses and auxiliary loads, over 10 years.
    d. Annual ESS savings will be generated by discharging the battery during on-peak periods, as well as during peak billing demand periods.
    e. Grid stability by ramping up and down ESS output in response to utility grid frequency.

2. Grid outage: The ESS must support critical loads in microgrid operation in the event of a grid outage.

    a. Install a microgrid control system and **[modify existing]** electrical distribution and automatic transfer schemes as necessary to provide electricity to the campus upon grid failure. The Contractor must include the creation of a critical power circuit, including re-wiring of the critical loads and installation of critical power switchgear, in the scope of work (SOW).
    b. The ESS must support the critical loads **[as indicated on drawings]**
    c. The ESS must perform anti-islanding sequence and grid forming operation to enable microgrid mode with "black start" capability.
    d. The ESS controller must disconnect load to prevent overload or over discharge and must manage charge/discharge function when utility grid is re-established.
    e. Consider the following site-specific parameters in the system design:

        1) [Specify site-specific operating conditions: provide electric load interval data, required ramp rates for existing generators, additional information on the types of loads to be served and required modes of operation. Provide detail on existing control and monitoring systems.]

2) Configure ESS to provide seamless transition between utility power and microgrid.
3) Optimize system to minimize generator use to conserve fuel.

C. Interval Testing:

1. The ESS must be demonstrated to perform on a recurring basis to ensure the Agency's desired site resilience and energy assurance. This interval testing frequency must occur approximately every twelve (12) months following final acceptance to ensure provision of power to the site in the event of a utility-provided power outage or interruption. This activity requires pre-coordination with the local servicing utility in accordance with the approved interconnection agreement, and that coordination must be led by the Contractor in consultation with the Agency's Facilities Manager (FM).
2. This periodic demonstration must stagger months, seasons, load, time of day, and weather variabilities, but must be conducted at least every twelve (12) months.
3. Periodic testing will be the responsibility of **[Specify entity responsible for O&M]**.
4. In the event of an actual utility power interruption exceeding **[insert specified duration]**, the ESS's performance will satisfy this requested demonstration, thereby resetting the interval to twelve (12) months prior to the next required demonstration.
5. Any deficiencies or anomalies beyond expected design parameters, in an actual event or demonstration event, are to be reported to the Agency within twenty-four (24) hours in writing, with recommended remediation or corrective steps to prevent recurrence.

2.4 ENERGY STORAGE COMPONENTS

A. Energy storage components must consist of **[lithium-ion batteries] [nickel-cadmium batteries] [nickel metal hydride batteries] [flow batteries] [lead-acid] [other battery or electrochemical ESS technology]**.

B. Energy storage systems may be individual cells, and supplied as modules comprised of cells, or as group of modules combined into units. Several units may be combined to make up the full installation. Cells, modules, and units must be fully enclosed in listed assembly for the intended purpose. Individual battery trays and/or racks must not be permitted.

C. Energy storage systems comprised of battery systems must be UL-1973 listed for the intended use.

D. A battery management system must monitor and balance cell voltages, currents, and temperatures within the manufacturer's specification. The battery management system must be part of the ESS component UL listing. The BMS must perform the charging and discharging of the equipment. The BMS must be field programmable via laptop and viewing/editing on a locally hosted web browser. Programming instructions and setpoints must be shared with Agency staff.

E. [The battery management system charge controller must have Maximum Power Point Tracking (MPPT) for DC coupled PV systems.]

F. The cells, modules, units, and installation must be supplied with all required and/or manufacturer recommended accessories.

G. ESS DC voltage must not exceed **[1000Vdc] [1500Vdc] [other DC voltage].**

H. The use of vented batteries must not be permitted.

2.5 POWER CONVERSION SYSTEMS

A. Power Conversion Systems (PCS) must be UL-1741 or UL-1741SA listed for the intended use.

B. PCS output must match local utility company frequency and voltage when grid tied to local utility or in combination with **[generator operation] [microgrid control system]** where applicable.

C. PCS output connections and operation must comply with all local utility company requirements.

D. PCS must have the following electrical characteristics:

1. Efficiency: minimum 95 percent
2. Frequency: 50/60 Hz
3. AC Voltage range: matching utility voltage
4. DC Voltage range: matching energy storage DC voltage
5. THD: < 3 percent
6. Power factor: -1 to +1

E. The PCS must have the following features to operate in the required performance scenario(s):

1. Perform grid-tie and grid-forming operation with “black start” capability and seamless transfer.
2. Bi-directional charge and discharge of the ESS with intelligent controls and interface with battery management system.
3. Complete automatic unattended operation including startup, synchronization, power disconnect, and parallel operation with the utility **[and generators]**. **[Where applicable, the system must also operate in parallel with: [photovoltaic systems,][generators,] [other site power production,][and utility]**.
4. Shutting down without damage when ESS output is outside tolerance parameters of inverter.
5. Automatic anti-islanding in conformance with referenced standards.
6. **[other features]**

2.6 MICROGRID CONTROL SYSTEM (MCS)

A. The MCS may be a separate component or combined with the ESS or inverter. The MCS must be one of the following: be listed, listed individual components assembled as a system, or designed under engineering supervision.

B. The MCS must include an energy management system (EMS), when an additional onsite generating source is present (i.e., solar or generators).

C. The MCS must have the following features to achieve the intended performance scenario(s): **<edit list of features as required for selected scenarios and system technology>**

1. Communicate with the ESS intelligent controls and monitor energy contribution from the **[Photovoltaic system,][generators,][other site power production].**
2. Monitor, log and report the energy consumption load profile.
3. The EMS must balance the power generation inputs, load outputs and signal controls to achieve the intended performance scenarios including grid services (such as peak demand shaving and energy arbitrage) and backup power to meet resiliency requirements.
4. Must autonomously initiate anti-islanding and grid forming sequence with battery power conversion system, generator controllers, or grid-forming inverters to operate in microgrid mode.
5. Have the ability to control the quantity and ratings of generation sources, utility, and output loads as indicated on drawings.
6. Communicate with, and directly control, connected generation sources including PV inverters, generator control panels, and battery converters. The MCS must be capable of coordinating the interaction between multiple power sources of similar or different types, manufacturers and technologies utilizing industry standard communication protocols.
7. Provide local and remote monitoring capability complying with this specification.
8. Be housed within the ESS or in separate enclosure complying with environmental conditions in this specification.
9. Include a programmable onsite interface to adjust the operating modes and threshold values.
10. Have the ability to log and export historical data from each connected generation source.

2.7 HEATING VENTILATION AND AIR CONDITIONING (HVAC)

A. The ESS must include a completely integrated HVAC system designed to always maintain component temperatures including heating, cooling, and relative humidity. Thermal conditioning systems must maintain ambient temperatures and humidity within warranty requirements and manufacturer recommendations.

2.8 ENCLOSURE

A. The ESS and associated equipment must be in a factory assembled climate-controlled enclosure that is rated for the site conditions.

B. The ESS, and associated equipment, must be provided in self-contained NEMA **[3R][4X]** enclosure(s) rated for the site conditions. ESS enclosures must be designed to be installed onto properly prepared pads/foundations.

C. Provide manufacturer **[standard enclosure finish][or][white enclosure finish]**.

D. ESS components and associated ancillary equipment must have working space clearances complying with OBO ICS NEC.

E. Energy storage modules or units must be rack mounted or installed in cabinets, per manufacturer recommendations inside factory enclosure or container. Each module or unit must be arranged to maintain required spacing and materials complying with UL-9540A testing recommendations and OBO Fire Code.

F. Front**[and rear]** access: All serviceable subassemblies must be modular and capable of being replaced from the front**[and rear]** of the cabinet. Side**[or rear]** access for installation, service, repair, or maintenance of the system must not be required.

G. Cable entry: standard cable entry for the ESS must be through the enclosure bottom.

2.9 DATA ACQUISITION AND CONTROL

A. The ESS must include a monitoring and data acquisition system and must include, at a minimum, the following information in 15-minute intervals (unless otherwise noted):

1. Real-time ESS State of charge
2. System mode (charge, discharge, island, grid-tied etc.) and condition (normal, auto, manual, override, etc.)
3. System voltages, current, and power
4. Real-time connected generation source(s) power and connected load power consumption.
5. Enclosure Ambient temperature, hourly average at hourly intervals.
6. Energy and time remaining at current discharge or charge rate
7. Time until full charge at current recharge rate
8. Forecasted charge and discharge profile
9. Round-trip efficiency on daily, weekly, monthly, yearly basis
10. System fire protection and alarm condition
11. Notification when preventive maintenance is needed
12. System alarm and events:

    a. Major: system automatically disconnected due to over/under voltage, overcurrent or over temperature.
    b. Minor: voltage imbalance, voltage sensing error, under-temperature, temperature imbalance, overprotection device activation, communication failure, regular maintenance required (i.e., perform balancing charge sequence)

B. Data must be saved locally for a minimum of **[(30) days][enter number of days]** and backed up off-site with a minimum of **[(36) months][enter number of months]** of data.

C. Data transmission must be transferred to off-site storage via one of the following connections:

1. Cellular connection
2. WAN Internet Connection **[coordinate with site specific conditions]**

D. Remote connection must be for monitoring purposes only. No system or device must require internet connection to function.

E. Local display and control:

1. Local display must provide listed data monitoring in this specification.
2. Local control panel via interface or dedicated server must allow for local control and adjustments of setpoints and threshold values.
3. Local display may be visible without password protection. Local control must be password and user protected.
4. Local display must have touch screen interface.

F. Monitoring by Building Automation System (BAS):

1. The ESS must communicate with an external controller via MODBUS over TCP/IP.
2. The ESS must provide monitoring data and reporting to the BAS. The BAS must not have capability to modify or control the ESS remotely.

G. External remote monitoring using web-based service:

1. All data collected will be available in a web-based interface accessed via an internet connection.
2. The Contractor must ensure that data acquisition and monitoring solution complies with site specific US Government cybersecurity.
3. Access must be provided via secure login ID and password:

   a. There will be no user-based fee to access the data
   b. An unlimited number of users can access the data at the same time

4. The user interface must have the following functionality:

   a. A site summary which provides data on the overall performance of the entire site
   b. Detailed asset views on each individual piece of connected equipment
   c. The ability to create time-data trends for all collected data.

2.10 FIRE PROTECTION AND FIRE ALARM SYSTEMS

A. The ESS must include an integrated fire protection and fire alarm system in accordance with UL-9540A test report and hazard mitigation analysis. Fire protection system must be water-based suppression type system unless approved by the OBO Fire.

B. The system must communicate with the compound Fire Alarm System.

C. Fire Protection System design must consider that ESS will be unattended at most times.

D. Provide visual and audible alarm when a safety hazard exists.

2.11 SOURCE QUALITY CONTROL

A. Factory end of line tests before shipment:

1. Factory test ESS and other system components and accessories manufactured specifically for this Project. Perform tests at rated power and for modes of operations in this specification.
2. All test results must be documented including failed tests.
3. Re-test all failed tests until successful test is achieved.
4. Factory testing must be witnessed by the US Government representative. Provide notification to Project Director/COR within 30 calendar days of scheduled test. US Government representative must perform factory inspection at that time as well.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before ESS installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes, and locations, and electrical to verify actual locations, sizes and other conditions affecting performance, maintenance, and operations.

1. Final ESS locations indicated on Drawings are approximate. Determine exact locations before roughing-in for electrical connections.

B. Provide required clearances and clear installation area of flammable vegetation. Maintain adequate setback to other structures, vegetation, and other flammable materials.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. The ESS must be provided with foundations and structures that are designed by or under the supervision of a qualified registered engineer. All design must be in accordance with local project area seismic design requirements and as specified in the specifications for this project.

B. Install equipment in accordance with manufacturer's installation instructions and recommendations.

C. ESS location must be above the **[insert year]** flood plain and surge levels and must be elevated higher than any pull vaults and conduit not sloped toward any ESS electrical component to prevent equipment flooding. ESS must be located within a thermally conditioned enclosure.

3.3 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section **[260518 "Low-Voltage Electrical Power Conductors and Cables."][Division 26 Section on MV conductor and cables.]**

C. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL-486A and UL-486B. Make a permanent mark on all joints, connectors, and terminals after they have been torqued to the proper value.

3.4 IDENTIFICATION

A. ESS signs must be clearly printed in English and in local language.

B. Identify components according to Division 26 Section on Identification for Electrical Systems and include the following:

1. Identification IAW OBO Electrical Code and OBO Fire Code referenced sections.
2. ESS electrical equipment and components must have clearly/visible markings that identify the manufacturer, size, type, rated input and output voltages, hazard warnings, frequency, number of phases (AC only), rating in kW or kVA, available fault current at ESS output terminals, maximum output and input current at terminals, maximum output and input voltage at terminals, and utility interactive capability.
3. Posted single line drawing (SLD), mimic bus, and instructions for tasks that site staff may need to perform, such as system shutdown during an emergency.
4. Clearly label all disconnects, indicating whether in the open (OFF) or closed (ON) position, the operating system voltage, available fault current, current, and system rating.
5. ESS disconnecting means must indicate whether ON or OFF and be marked “ENERGY STORAGE SYSTEM DISCONNECT.” Disconnecting means must also be clearly marked to indicate: (1) Nominal ESS voltage, (2) Available fault current, (3) Arc-flash label, (4) Date calculation performed.
6. Arc flash labels, per NFPA-70E.
7. Identification and location of each power source on a permanent plaque or directory. The plaque or directory must indicate the location of each power source disconnecting means and be grouped with other plaques or directories for other power sources.

C. Equipment markings must be permanent and must withstand the environmental conditions in which the equipment is installed. Provide “UV rated” for outdoor labels, or on an embossed steel placard, designed for outdoor use and fastened with adhesive and rivets.

D. Markings must be visible or easily accessible during and after installation. The Contractor must be responsible for all field-applied markings as required by local, state, and federal codes.

3.5 FIELD QUALITY CONTROL AND STARTUP

A. Provide the services of a qualified and certified factory-trained manufacturer’s representative for startup of the equipment specified under this section. The manufacturer’s representative must provide technical assistance to the contractor in general installation of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The manufacturer’s representative must provide inspection of the final installation, perform functional testing, and startup the ESS.

C. Startup acceptance test must be witnessed by the US Government representative. Provide notification to Project Director/COR within 30 calendar days of scheduled test. Contractor must be prepared at any time during this process to provide access to all portions of installation and must remedy any portion of system that is not in compliance with this specification, which does not perform to manufacturer's operating specifications, or that fails to operate due to poor workmanship.

D. Ensure there is written permission from local utility company for interconnection of the ESS with the utility grid. Local utility company may require that representative of the local utility be onsite during initial interconnection; Contractor must accommodate this requirement, if stated by utility.

E. Functional Testing must include the following, in addition to all tests required by manufacturer:

1. Pre-startup inspection of the ESS system.
2. Test in accordance with the approved operating scenarios.
3. Verify and test system alarms.
4. Test ESS with all power generating sources and loads as applicable.

F. Provide photo record of installation and major components, including ESS, MCS, and all display screens. Include photos showing connections within all installed enclosures. Provide electronic copies of photo record on compact disc and hard copy of the photo record (with labels for each photo) in Operation and Maintenance Manual identified in Article on SUBMITTALS.

3.6 COMMISSIONING

A. Third Party Commissioning Agent: Engage electrically qualified and factory approved third-party certified commissioning agent to inspect, field test, and document performance of components and equipment after installation. Commissioning agent must prepare written test results in report.

B. All test instruments must be identified in Report and listed by manufacturer, model number, serial number, date of calibration, and calibration authority. All test instruments must have been calibrated within past year. Test instruments must have attached calibration sticker that is traceable to NIST.

C. Contractor must obtain written commissioning procedures document. Procedure entries must include date; time; person taking data; recorded value of data; indication if recorded value is out of range of system and/or equipment tolerance. Each page of the procedures must have test name; equipment tested; location; date; time; person performing test; model number of equipment; serial number of equipment; manufacturer; tolerance ranges of equipment tested for reference.

D. Commissioning Agent must keep Commissioning Issues Log and include it as appendix to Report. Log must include, but not be limited to issue description; log tracking number; date; time; person investing issue; action taken; person acting; date of closure of issue. Include copy of Commissioning Issues Log in written procedures to Contractor.

E. Perform the following field tests and inspections, in addition to manufacturer recommended tests and inspections, as follows for test report:

1. Test insulation resistance and continuity for each DC circuits, AC feeders, grounding including ground fault protection, and control circuits. Disconnect all sensitive electronic equipment prior to testing. Visually and physically inspect all cabling, connections, and conduits. Verify color coding of conductors per OBO Electrical Code. Verify proper torque of termination connections with calibrated torque wrench.
2. Test ground fault protection of ESS (where required).
3. State of Health verification via coulomb counting.
4. Test proper operation of ESS for all operating scenarios. Set output voltage, as necessary. Verify that all local utility notifications and requirements have been incorporated.
5. Verify operation of all disconnect switches and proper sizing of all overcurrent protection devices (OCPD) in accordance with Division 26 Sections on enclosed switches and circuit breakers and on panelboards.
6. Verify that displays accurately represent output of ESS.
7. Power feedback controller: Monitor the utility power factor with the ESS functioning and with it disconnected. Identify the observed power factor. Verify the system modulates this power factor to not adversely affect utility billing.
8. Verify that remote data logging access has been established and is functioning. Provide all necessary data, IP addresses, login-ins, and passwords to post.

F. Contractor must remove and replace malfunctioning equipment. Retest ESS system as specified above.

3.7 DEMONSTRATION AND TRAINING

A. Comply with Division 01, Section 017905 *Demonstration and Training* for general requirements of demonstration and training documentation.

B. The manufacturer's representative must provide 'hands-on' training course for the US Government O&M personnel.

1. Schedule as follows:

   a. Two (2) eight (8) hour training sessions equally divided into in-class training and in the field training, for a total of sixteen (16) hours.
   b. Training must be completed within two (2) calendar weeks

2. Training must cover the following topics:

   a. Overall system description and theory of operation.
   b. Local displays and control interfaces.
   c. Operating scenarios.
   d. Automatic operation.
   e. Manual operation.
   f. Protective relaying.
   g. Recommended system checklists and log sheets.
   h. Recommended preventive maintenance and instructions to be performed by qualified staff.

i. Instruction on the operation of the assembly, and major components within the assembly.
j. Instruction on operation or maintenance that must be completed by factory authorized representative to maintain warranty and proper operation.
k. Fire protection and fire alarm system operation and procedures for the safe operation and actions during fire event or alarm.
l. Interactions with other systems.
m. Overview of relevant storage chemistry, internal thermal management system, and required ambient housing conditions to maintain required operating temperature range.
n. Identification of emergency disconnects.
o. Fire suppression system maintenance – pump and distribution system maintenance for dry standpipe systems.
p. Instruction on balancing cycle and state of charge tests to gauge state of health
q. Hazards and failure modes, including thermal runaway, off gassing, and stranded energy.
r. Mitigation / response measures for electrolyte releases, overheated batteries and fires.
s. Instruction in liquid-cooled system maintenance, including pump and coolant inspection, leak detection, visual inspection, and verification of pressure and gauge accuracy.
t. Power conversion system inspection and calibration.

C. The Contractor and Manufacturer's representative must coordinate with local fire marshals on ESS setback requirements, first responder training, and posted instructions for shutoffs:

1. The Contractor must provide training to local firefighters covering ESS operation and how to shut it down in an emergency event and form a fire suppression plan. Training must cover the main risks of storage systems, including electric shock, thermal runaway, battery reignition, and stranded energy. Training must include fire suppression tactics, including minimum water and time requirements, thermal imaging camera, vehicle tilt / lift, and battery box piercing, as well as extrication and transport.
2. The Contractor must coordinate with the fire marshal to determine where to post the permanent instructions and required markings.

D. The Contractor must provide a minimum four (4) hour online training to US Government O&M personnel, Government IT personnel, and OBO representative of the remote monitoring systems via online web services tools. The training must be recorded and remain available for ongoing access to training. The training must include:

1. Login credentials and request for additional users
2. Menu options and available information
3. Review of graphical displays, data, and components
4. Interpretation of presented data
5. Optional displays and updates

END OF SECTION 263313.13

SECTION 263354 – UNINTERRUPTIBLE POWER SUPPLY (UPS) FOR TELECOMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes operation and functionality of continuous-duty Uninterruptible Power System (UPS) used in in Telecommunications equipment spaces, and other incidental components to support a fully operational telecommunication system.

B. The Joint Unclassified Computer Room (JUCR) UPS shall utilize rack-mounted redundant, scalable array architecture, with hot-swappable/user-replaceable power modules. Major subcomponents include:

1. Input Power Converter.
2. Output Inverter.
3. Static Bypass Switch.
4. Maintenance Bypass Panel (MBP).
5. Power Distribution Unit (PDU).
6. Extended runtime cabinet.
7. Battery system.
8. Displays and Controls.

C. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications and Electronic Safety” for facility voltages.
2. Section 260573 “Overcurrent Protective Device Study.”
3. Section 270508 “Common Work Result for Telecommunications.”
4. Section 270526 “Grounding and Bonding for Communications Systems” for grounding bus bars and ground conductors.
5. Section 271116 "Communications Cabinets and Frames."

1.2 DEFINITIONS

A. “Joint Unclassified”: “Unclassified” in this context refers to the fact that “classified” systems are not permitted in the JUCR. While systems handling “Sensitive But Unclassified (SBU)” content is permitted in the JUCR, content that is SBU/NOFORN is also not permitted.

B. EMI: Electromagnetic interference.

C. LCD: Liquid-crystal display.

D. LED: Light-emitting diode.

E. THD: Total harmonic distortion.

F. UPS: Uninterruptible power supply.

1.3 STANDARDS

A. EMC Directive 89/336/EEC.

B. EMC Directive 73/23EEC.

C. EN/IEC 62040-1-1, EN/IEC/UL60950-1, UL 1778, UL1973.

D. EN 50091-2 / IEC 62040-2 (class A), FCC15A.

E. EN/IEC62040-3 (VFI-SS-111).

F. IEC 62040-2 / EN/IEC 61000-4:

1. 2 level 3.
2. 3 level 2.
3. 4 level 2.
4. Manufacturer-defined as 5 Level 3 in accordance with referenced standard.

1.4 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance for each UPS component indicated.

B. Shop Drawings: Include partial enlarged floor plan to show access, workspace, clearance, and cable layout. Include enlarged equipment elevations at racks where UPS is located. Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

1. Wiring Diagrams: Power, signal, and control wiring.

C. [Manufacturer Seismic Qualification Certification: Submit certification that UPS equipment will withstand seismic forces defined in Division 26 Section on vibration and seismic controls for electrical systems when anchored to concrete base. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. Term "withstand" means "unit will remain in place without separation of any parts from device when subjected to seismic forces specified and unit will be fully operational after seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.]

D. Qualification Data: For Installer, power quality specialist, manufacturer and testing agency.

E. Manufacturer Certificates: For each product, signed by manufacturers.

F. Factory Test Reports: Demonstrating compliance with specified requirements.

G. Field Quality-Control and Performance Test Reports: Indicate test results compared with specified performance requirements and provide justification and resolution of differences if values do not agree.

H. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Systems Manual and O&M Data," include the following:

1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
2. Detailed operating instructions covering operation under both normal and abnormal conditions.

I. Warranties: Special warranties specified in this Section.

1. Special Installer Extended Warranty: Installer warrants that fabricated and installed UPS system performs in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

   a. Extended-Warranty Period: **[Two]** years from date of Substantial Completion; full coverage for labor, materials, and equipment.

2. Special Manufacturer Extended Warranty: Manufacturer warrants that UPS system performs in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

   a. Extended-Warranty Period: **[Two]** years from date of Substantial Completion; prorated coverage for labor, materials, and equipment.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is authorized representative of UPS manufacturer for both installation and maintenance of units required for this project.

B. Manufacturer Qualifications: A firm who maintains service center capable of providing training, parts, and emergency maintenance and repairs for equipment at Project site, with 48 hours' maximum response time.

C. Source Limitations: Obtain UPS and associated components specified in this Section from single manufacturer with responsibility for entire UPS installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces with environments controlled within manufacturers' ambient temperature and humidity tolerances for non-operating equipment.

C. Storage of UPS is limited to six months prior to final commissioning.

D. On-site and identified with labels describing contents.

1.7 WARRANTY

A. Warranties, General: Special warranties specified in this Article shall not deprive Government of other rights Government may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Battery Warranties: Written warranty, signed by manufacturer and Installer agreeing to replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for Premium Sealed Lead-Acid Batteries: Equal or greater than that represented in manufacturer's published table, including figures corresponding to the values in Table 1.8, “Warranted Battery Cycle Life,” based on annual average battery temperature of 25 deg C:

TABLE 1.8
WARRANTED BATTERY CYCLE LIFE

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	40 cycles
30 minutes	30 minutes	1.67	125 cycles
15 minutes	1 minute	1.67	750 cycles

C. Special UPS Warranties: Written warranties, signed by manufacturer and Installer agreeing to replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: Two years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but not less than one of each.
2. Cabinet Ventilation Filters (if so equipped): One complete set.
3. One spare Power Module.
4. One spare Intelligence Module.

1.9 MAINTENANCE SERVICE

A. Commencing at the contract’s Substantial Completion date for a period of one calendar year provide system maintenance service based on manufacturer's recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. In addition to the initial year of maintenance service, provide a proposal for a renewable option year. The option year proposal shall be submitted 60 days prior to the end of the initial maintenance contract period.

B. The intent is to provide full maintenance service, including cooling system maintenance, load testing, firmware and software updates, cleaning, visual inspection, and environmental monitoring.

C. Maintenance service shall include preventive maintenance, repair or replacement of worn or defective components, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks shall also align with the manufacturer's recommended checklists as required in Division 01 Section 017825 "Systems Manual and O&M Data." Provide completed maintenance records inclusive of scheduling to the USG for inclusion in the CMMS.

PART 2 - PRODUCTS

2.1 JUCR UPS SYSTEM REQUIREMENTS AND CHARACTERISTICS

A. Coordinated System Performance: JUCR UPS and associated equipment shall operate in conjunction with primary power supply and output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.

B. Power Characteristics: **[380 or 400 volt, 50 Hz]**.

C. Project-Specific Design: Refer to Drawings and coordinate with the following:

1. Project-specific voltage and frequency utilized.
2. Rack layout.
3. UPS size and special accessories.
4. Circuit breaker sizes.
5. Cable lengths.

D. UPS Capacity: Size for 3.5 kW per cabinet for number of cabinets indicated on Drawings.

E. UPS Battery Capacity: Size to support continued operation of equipment on cabinet for **[30][60]** minutes.

F. Short Circuit Withstand Rating: Coordinate with analysis for Section 260573 “Overcurrent Protective Device Study” and with Drawings; minimum permissible rating is 30kA Symmetrical minimum with gL/gG fuse in front of system.

G. System Configuration: System shall be rated for full kW output in the following frame sizes:

1. Total scalable kVA/kW shall be based on design indicated on Drawings, and shall be configured using power modules in accordance with manufacturer’s standard system.

   a. Provide **[N+1]** Redundancy units.

2. Each scalable size varies by manufacturer, but scalable size shall not exceed **[16kVA/16kW]** power module shall contain a full-rated input rectifier and boost converter (Input Converter), full rated output inverter, and battery charging circuit.
3. System shall include the following module types which shall operate in parallel:

   a. User-replaceable continuous duty hot swappable bypass static switch modules.
   b. Hot-swappable/user-replaceable battery modules.
   c. Redundant control modules.

H. Housing: House system components in standard 600mm wide, 1070mm deep, 2000mm high equipment rack; see Section 271116 “Communications Cabinets and Frames.”

I. System Input:

1. AC Input Nominal Voltage: Site Distribution Voltage, with L1,L2,L3,N, and ground.
2. AC Input Voltage Window: 340 - 477 at 100 percent load and 200 - 477 at 50 percent load
3. Maximum Frequency Range: 40-70Hz (autosensing).
4. Input Power Factor: Greater than 0.99 at load greater than 25.
5. Input Current Distortion with no additional filters: Less than 5 percent at 100 percent load.
6. Soft-Start: Shall be linear from 0-100 percent input current and shall not exhibit inrush. Soft-start shall take place over 10 seconds time period.

J. Battery Characteristics:

1. Nominal Battery voltage: Plus/minus 192Vdc (2×96 cells at 2V)
2. Float voltage: Plus/minus 218Vdc (2×96 cells at 2.27V)
3. End of discharge voltage (full load): Plus/minus 154Vdc (2×96 cells at 1.6V)
4. End of discharge voltage (no load): Plus/minus 168Vdc (2×96 cells at 1.75V)

K. Battery Charging Characteristics:

1. 10 percent of output power at low input voltage and 100 percent load.
2. 20 percent of output power at nominal voltage and 100 percent load (optional).

L. UPS Output:

1. AC Output Nominal Output: Site Distribution Voltage, with L1, L2, L3, N, and ground.
2. Output frequency regulation: Synchronize frequency to bypass input when available over standard range of 47 to 53 Hz. Optional plus/minus 0.1 Hz and plus/minus 10 Hz setting from front panel. When no bypass input is present, output frequency shall be 50 Hz.
3. AC Output Voltage Regulation: Plus/minus 1percent for 100 percent linear load, plus/minus 3 percent for 100 percent non-linear load.
4. Voltage Transient Response: Plus/minus 5 percent maximum for 100 percent load step.
5. Voltage Transient Recovery within less than 50 milliseconds.
6. Output Voltage Harmonic Distortion:

    a. Less than 2 percent THD maximum for 100 percent linear load.
    b. Less than 5 percent THD maximum for 100 percent non-linear load as defined by EN50091-3/IEC 62040-3.

7. Overload Rating:

    a. Normal and battery Operation:

        1) 150 percent for 60 seconds in normal and battery operation.
        2) 125 for 10 minutes in normal and battery operation.

    b. Bypass Operation:

1) 125 percent continuous.
2) 1000 percent for 100 milliseconds.

8. System AC-AC Efficiency: Greater than 95 percent at 35–100 percent load.
9. Output Power Factor Rating: For loads exhibiting a power factor of 0.5 leading to 0.5 lagging no derating of the UPS shall be required.

M. Audible Noise Limitations: Nominal max at 1 meter from surface of unit.

1. Lesser than 57dBA at greater than 70 percent load.
2. Lesser than 63dBA at 100 percent load.

N. Altitude Adjustments: Maximum installation with no derating of the UPS output shall be 1000m above sea level.

1. 1500 m: 95 percent load.
2. 2000 m: 91 percent load.
3. 2500 m: 86 percent load.
4. 3000 m: 82 percent load.

2.2 MANUFACTURERS

A. Availability of Service Personnel: Manufacturers shall have worldwide service organization, with factory-trained service personnel available within 5000 kilometers to be able to provide support 24 hours a day, 7 days a week, 365 days a year.

B. Availability of Spare Parts: Manufacturers shall have worldwide component and system distributorships, with replacement parts available from manufacturer using their regularly available expediting delivery for receipt within 24 hours of request.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. APC Symmetra PX UPS
2. Chloride UPS
3. Eaton UPS

2.3 MODES OF OPERATION

A. Normal: Input converter and output inverter shall operate in on-line manner to continuously regulate power to critical load. Input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to load for all line and load conditions within range of UPS specifications.

B. Battery: Upon failure of AC input source, critical load shall continue being supplied by output inverter, which shall derive its power from battery system. There shall be no interruption in power to critical load during both transfers to battery operation and retransfers from battery to normal operation.

C. Recharge: Upon restoration of AC input source, input converter and output inverter shall simultaneously recharge battery and provide regulated power to critical load.

D. Static Bypass: Static bypass shall be used to provide transfer of critical load from Inverter output to bypass source. This transfer, along with its retransfer, shall take place with no power interruption to critical load. In event of emergency, this transfer shall be automatic function.

E. Maintenance Bypass: Equip system with Maintenance Bypass Panel (MBP) used to electrically isolate UPS and supply load directly from mains supply, if UPS system has to undergo maintenance or service.

2.4 INPUT POWER CONVERTER

A. House converters within parallel connected, removable power modules. Converters shall constantly control power imported from mains input of system to provide necessary UPS power for precise regulation of DC bus voltage, battery charging, and Main Inverter regulated output power.

B. Input Current Total Harmonic Distortion: Hold input current THDI to 5 percent or less at full system, while providing conditioned power to critical load bus, and charging batteries under steady-state operating conditions. This shall be true while supporting loads of both linear or non-linear type, and shall be accomplished with no additional filters, magnetic devices, or other components.

C. Soft-Start Operation: UPS shall contain soft-start functionality, capable of limiting input current from 0-100 percent of nominal input over default 10 seconds period, when returning to AC utility source from battery operation. Change in current over change in time shall take place in linear manner throughout entire operation (di/dt= constant).

D. Magnetization Inrush Current: UPS shall exhibit 0 inrush current.

E. Input Current Limit:

1. Input converter shall control and limit input current draw from utility to 135 percent of UPS output. During conditions where input current limit is active, UPS shall be able to support 100 percent load, charge batteries, and provide voltage regulation.
2. In cases where source voltage to UPS is nominal and applied UPS load is equal to or less than 100 percent of UPS capacity, input current shall not exceed 110 percent of UPS output current while charging batteries.

F. Charging:

1. Battery charging circuit shall contain temperature compensation circuit which shall regulate battery charging to optimize battery life.
2. Battery charging circuit shall remain active when in requested Static Bypass and in Normal Operation.
3. Back-feed Protection: Use logic controlled contactor to provide back-feed protection.

2.5 BATTERY

A. Modular construction made up of user replaceable, hot swappable, fused, battery modules. Each battery module shall be monitored for voltage and temperature for use by UPS battery diagnostic, and temperature compensated charger circuitry.

B. Battery block housed within each removable battery module shall be of **[Valve Regulated Lead Acid (VRLA)][Lithium-ion]**.

C. UPS shall incorporate battery management system to continuously monitor health of each removable battery module. This system shall notify user in event that failed or weak battery module is found.

D. Battery management system shall monitor at the cell level to manage voltage for Lithium-ion batteries.

2.6 OUTPUT INVERTER

A. The UPS output inverter shall constantly recreate UPS output voltage waveform by converting DC bus voltage to AC voltage through set of IGBT driven bi-directional power converters. In both normal operation and battery operation, output inverters shall create an output voltage independent of mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect amplitude or sinusoidal nature of recreated output voltage sine wave of output inverters.

B. Overload Capability: Steady-state overload conditions of up to 150 percent of system capacity shall be sustained by inverter for 60 seconds in normal and battery operation. Should overloads persist past outlined time limitation, critical load shall be switched to automatic static bypass output of UPS.

C. Output Contactor: Provide output inverter with output mechanical contactor to provide physical isolation of inverter from critical bus. With this feature, failed inverter shall be removed from critical bus.

D. Battery Protection: Provide inverter with monitoring and control circuits to limit level of discharge on battery system.

E. Redundancy: Configure UPS with redundant output inverters, each with semiconductor fusing, and logic controlled contactors to remove failed component from critical bus.

2.7 STATIC BYPASS

A. As part of UPS, provide system static bypass switch. System static bypass shall provide no break transfer of critical load from inverter output to static bypass input source during times when maintenance is required or when inverter cannot support critical bus (such times may be due to prolonged or severe overloads, or UPS failure). UPS and static bypass switch shall constantly monitor auxiliary contacts of their respective circuit breakers, as well as bypass source voltage, and inhibit potentially unsuccessful transfers to static bypass from taking place.

B. Static switch power path shall consist of Silicon Controlled Rectifiers (SCR) with continuous duty rating of 125 percent of UPS output rating.

C. Automatic Transfers: Automatic transfer of load to static bypass shall take place whenever load on critical bus exceeds overload rating of UPS. Automatic transfers of critical load from static bypass back to normal operation shall take place when overload condition is removed from critical bus output of system. Automatic transfers of load to static bypass shall also take place if for any reason UPS cannot support critical bus.

D. Manual Transfers: Manually initiated transfers to and from static bypass shall be initiated through UPS display interface.

E. Overloads: Static bypass shall be rated and capable of handling overloads equal to or less than 125 percent of rated system output continuously. For instantaneous overloads caused by inrush current from magnetic devices or short circuit conditions, static bypass shall be capable of sustaining overloads of 1000 percent of system capacity for periods of up to 100 milliseconds.

F. Static bypass switch shall be of modular design and hot swappable.

G. System Protection: Incorporate back-feed protection in static bypass circuit. To achieve back-feed protection, mechanical contactor in series with bypass SCR(s) shall be controlled by UPS/static switch to open immediately upon sensing condition where back-feeding of static switch by any source connected to critical output bus of the system is occurring.

2.8 DISPLAY AND CONTROLS

A. Control Logic: Control UPS by two fully redundant, user-replaceable/ hot-swappable control modules. These modules shall have separate, optically isolated, communication paths to power and static switch modules. Derive logic power for control modules from redundant power supplies, each having separate AC and DC input and output. Communication of control modules shall be of Controller Area Network (CAN Bus).

B. Display Unit: Locate microprocessor controlled display unit on hinged door in front of system. Display shall consist of alphanumeric display with backlight, four LEDs for quick status overview, and keypad consisting of pushbutton switches.

C. Metered Data: The following metered data shall be available on alphanumeric display:

1. Year, Month, Day, Hour, Minute, Second of occurring events
2. Source Input Voltage
3. Output AC voltage
4. Output AC current
5. Input Frequency
6. Battery voltage

D. Event log: Display unit shall allow user to display time and date stamped log of most recent status and alarm events.

E. Alarms: Display unit shall allow user to display log of all active alarms. Provide the following minimum set of alarm conditions:

1. Input Frequency outside configured range
2. AC adequate for UPS but not for Bypass
3. Low/No AC input, startup on battery
4. Intelligence Module inserted
5. Intelligence Module removed
6. Redundant Intelligence Module inserted
7. Redundant Intelligence Module removed
8. Number of Batteries changed since last ON
9. Number of Power Modules changed since last ON
10. Number of Batteries increased
11. Number of Batteries decreased
12. Number of Power Modules increased
13. Number of Power Modules decreased
14. Number of External Battery Cabinets increased
15. Number of External Battery Cabinets decreased
16. Redundancy Restored
17. Need Battery Replacement
18. The Redundant Intelligence Module is in control
19. On Battery
20. Shutdown or unable to transfer to battery due to overload
21. Load Shutdown from Bypass. Input Frequency Volts outside limits
22. Fault, Internal Temp exceeded system normal limits
23. Input Circuit Breaker Open
24. System level fan failed
25. Bad Battery Module
26. Bad Power Module
27. Intelligence Module is installed and failed
28. Redundant Intelligence Module is installed and failed
29. Redundancy has been lost
30. Redundancy is below alarm threshold
31. Runtime is below alarm threshold
32. Load is above alarm threshold
33. Load is no longer above alarm threshold
34. Minimum Runtime restored

35. Bypass is not in range (either frequency or voltage)
36. Backfeed contactor stuck in OFF position
37. Backfeed contactor stuck in ON position
38. UPS in Bypass due to Internal Fault
39. UPS in Bypass due to overload
40. System in Forced Bypass
41. Fault, Bypass Relay Malfunction
42. High DC Warning
43. High DC Shutdown
44. Low Battery Shutdown
45. Low Battery Warning

F. Controls: Accomplish the following controls or programming functions by use of display unit. Pushbutton membrane switches shall facilitate these operations.

1. Silence audible Alarm
2. Display or set the date and time
3. Enable or disable the automatic restart feature
4. Transfer critical load to and from static bypass
5. Test battery condition on demand
6. Set intervals for automatic battery tests
7. Adjust set points for different alarms
8. Program the parameters for remote shutdown.

G. Potential Free (Dry) Contacts: Provide the following potential free contacts on relay interface board:

1. Normal Operation
2. Battery Operation
3. Bypass Operation
4. Common Fault
5. Low Battery
6. UPS Off

H. Communication Interface Board: Board shall provide the following communication ports which can be used simultaneously:

1. RS232 Serial Port #1

2.9 MAINTENANCE BYPASS PANEL (MBP)

A. Maintenance bypass panel, housed within same UPS cabinet, shall enable UPS system to be transferred to maintenance bypass mode and to be isolated for essential maintenance. Maintenance bypass panel shall contain protection of all UPS/external static-switch feeder and outgoing busbars and all necessary ACB/isolating switch interlocking to allow fail-safe start-up, shutdown and transfer to maintenance bypass.

2.10 POWER DISTRIBUTION UNIT (PDU)

A. General:

1. House 100A rated Modular Power Distribution Unit within UPS frame.
2. Provide PDU with 18 pole positions available for installation of modular output distribution breakers. Provide feeds to server racks with single or three pole 16A or 32A circuit breakers. Channel power to cabinets from PDU via overhead power feeds exiting through top of PDU. Feeds shall lay across top of cabinets via overhead troughing system. These troughs shall sit on top of cabinets and shall be of tool-less installation. Provide PDU with branch circuit monitoring that links to management system interface.

B. Electrical:

1. House PDU functionality within same frame as UPS, with both in standard 600mm IT equipment rack.
2. Provide PDU with at least one 3-phase distribution panel. Feed panel by output of 3-phase Symmetra modular UPS system. Panel shall be rated for Site Distribution Voltage, L1, L2, L3, N, PE. Populate PDU with standard modular distribution breakers either as 1p (18) or 3p (6), or with RCD breakers either as 1p (9) or 3p (3).
3. Input and Output distribution for panel shall be from top, with power cables provided by UPS vendor connecting distribution breakers identified elsewhere in this Article to equipment rack. Provide each cable with IEC-309 plug that connects to rack PDU (outlet strip). Length of power cable shall be related to layout of IT room equipment racks.

2.11 BATTERY DISCONNECT BREAKER

A. Provide each UPS sized for system (e.g., 250A 500Vdc-rated) thermal-magnetic trip molded-case circuit breaker. Equip each circuit breaker with shunt trip mechanism and 1A/1B auxiliary contacts (1 AUX contact for the internal DC circuit breaker). Locate circuit breakers within UPS enclosure or as part of line-up-and-match type battery cabinet.

2.12 MAINTENACE BYPASS

A. Maintenance bypass shall provide power to critical load bus from bypass source during times when maintenance or service of UPS is required.

B. Provide sized for system in front of Mains input. For dual mains, provide 80A gL fuse on bypass input.

2.13 SOFTWARE AND CONNECTIVITY

A. Network Adaptor: Ethernet Web/SNMP Adaptor shall allow one or more network management systems (NMS) to monitor and manage UPS in TCP/IP network environments. Provide management information base (MIB) in DOS and UNIX "tar" formats.

B. Unattended Shutdown

1. UPS, in conjunction with network adaptor, shall be capable of simply, quickly, and reliably shutting down one or more operating systems.
2. UPS shall also be capable of using an RS232 port to communicate by means of serial communications to gracefully shut down one or more operating systems during an on battery situation.

2.14 REMOTE UPS MONITORING

A. Provide the following three methods of remote UPS monitoring:

1. Web Monitoring: Remote monitoring via web browser such as Internet Explorer.
2. RS232 Monitoring: Remote UPS monitoring via either RS232 or contact closure signals from UPS.
3. Simple Network Management Protocol (SNMP): Remote UPS Monitoring through standard MIB II compliant platform.

2.15 SOFTWARE COMPATIBILITY

A. UPS manufacturer shall provide software to facilitate simple, quick, and reliable attended and unattended shutdown and remote monitoring for the latest Microsoft Office version currently in use by Department of State. Verify with the Project Director/COR.

2.16 RACK-MOUNTED UNINTERRUPTIBLE POWER SUPPLIES AND BATTERY EXTENDERS (UPS)

A. Install UPS in every Contractor-furnished telecom cabinet and each section of a colocation cabinet except for the voice cabinets. Reserve 8 Rack Units in each voice cabinet in each telecom room for GFGI UPS; see Section 271116 “Communications Cabinets and Frames.”

1. Rack-mounted Smart UPS by American Power Conversion Corp. (APC). No substitutions are permitted. Rack Mounted Uninterruptable Power Supplies: Provide UPS units and accessories in the following configurations. Maximum power load for one UPS shall be half of the total rack load. Provide dedicated power strip for UPS.

B. APC UPS units for Telecom Cabinets:

1. Applicable to classified (See J.3.5) and unclassified networks to include, but not limited to (OpenNet, Spare 1 and Spare 2, RNER). Mount at bottom of each cabinet and in each section of colocation cabinet.
2. Provide 15 minutes of runtime capacity in telecommunications cabinets at **[xx]** watts per switch.
3. Calculate total UPS output required based upon manufacturer product data and use battery module(s) to extend runtime.
4. Provide one network card per UPS of this type.
5. Relay I/O Module: AP9610; provide for each UPS.
6. Rackmount Rails: APC 4-Post.
7. Rackmount Powerstrip.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install UPS components in accordance with manufacturer's instructions.

B. Provide one (1) dedicated 50A, 208Y/120V, 3-phase branch circuit from the JUCR electrical panel to a J-box mounted above the Owner Furnished Owner Installed (OFOI) Voice cabinet. The circuit shall include conductors rated for continuous duty and sized in accordance with OBO standards and adopted NFPA 70 modifications, including any applicable derating. The government (Diplomatic Technology (DT)) shall furnish and install the appropriate cord/cable and conduit from the OFOI voice UPS input to the J-box, including all final terminations**.**

C. Provide low-voltage control cabling (with a 4.5m / 15-foot service loop) from the Emergency Power Off (EPO) in the JUCR to a dedicated J-box above the OFOI voice cabinet. Terminate the cable on the EPO. The cabling shall meet the type and rating required for a UPS EPO input. DT shall connect the OFOI voice UPS to the EPO via the provided cabling. All work shall comply with manufacturer requirements, OBO standards, adopted NFPA 70 modifications, and shall be subject to inspection by the government.

3.2 FACTORY-ASSISTED START-UP FOR JUCR UPS

A. Factory trained service personnel shall perform inspections and test procedures identified in this Article, and on-site training required in this Section. Perform each visual and mechanical inspection and electrical test identified in NETA ATS. Certify compliance with test parameters.

B. Contractor shall perform start-up work in accordance with applicable construction security requirements identified in Division 01 Sections.

C. Visual Inspection:

1. Inspect equipment for signs of damage.
2. Verify installation in accordance with manufacturer's instructions.
3. Inspect cabinets for foreign objects.
4. Inspect Battery Units.
5. Inspect Power Modules.

D. Mechanical Inspection:

1. Check all UPS and external maintenance bypass cabinet internal control wiring connections.
2. Check all UPS and external maintenance bypass cabinet internal power wiring connections.
3. Check all UPS and external maintenance bypass cabinet terminal screws, nuts, and/or spade lugs for tightness.

E. Electrical Inspection:

1. Verify correct input and bypass voltage.
2. Verify correct phase rotation of all mains connections.
3. Verify correct UPS control wiring and terminations.
4. Verify voltage of all battery modules.
5. Verify neutral and ground conductors are properly landed.
6. Inspect external maintenance bypass switch for proper terminations and phasing.

F. Monitoring and Testing Schedule: Follow manufacturer's instructions, and document with appropriate dates and observations to preserve warranty.

1. Ensure proper system start-up.
2. Verify proper firmware control functions.
3. Verify proper firmware bypass operation.
4. Verify proper maintenance bypass switch operation.
5. Verify system set points.
6. Verify proper inverter operation and regulation circuits.
7. Simulate utility power failure.
8. Verify proper charger operation.
9. Document, sign, and date all test results.

3.3 TRAINING FOR JUCR UPS

A. Training During Startup: During JUCR UPS factory-assisted start-up, factory-trained technician shall provide 2-day operational on-site training for post personnel (as identified by Project Director/COR). Topics shall include keypad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

B. Training Prior to Closeout: Factory-trained technician shall provide 2-day JUCR UPS service on-site training workshop for post personnel (as identified by Project Director/COR). Workshop format shall include combination of lecture and practical instruction with hands-on laboratory

sessions. Workshop content shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.

END OF SECTION 263354

SECTION 263535 - POWER FACTOR CORRECTION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes power and automatic power factor correction equipment rated 600 V and less.

B. Related Sections:

1. Division 26 Section on “Identification for Electrical Systems.”
2. Section 260915 “Electrical Power Monitoring.”

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions, operating characteristics of multiple capacitor cells or elements, and data on features, ratings, and performance.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals. Include the following:

1. Lists of spare parts and replacement components recommended for storage at Project site.
2. Detailed instructions covering operation under both normal and abnormal conditions.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Comply with IEEE 18 and NEMA CP 1.

C. Comply with requirements of the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.4 COORDINATION

A. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Section 260915 "Electrical Power Monitoring" for successful transmission and remote readout of remote monitoring data specified in this Section.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Government.

1. Fuses: One for every 10 of each type and rating, but not less than three of each.

PART 2 - PRODUCTS

2.1 CAPACITORS, GENERAL

A. Unusual Service Conditions: Capacitor equipment suitable for the following conditions:

B. Construction: Multiple capacitor cells or elements, factory wired in three-phase groups and mounted in metal enclosures.

C. Capacitor Cells: Dry, metallized-dielectric, self-healing type. Each cell shall be encapsulated in thermosetting resin inside plastic container.

D. Cell Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

E. Capacitor-Bank Fuses: Where required, current-limiting, noninterchangeable type; factory installed in each phase and located within the equipment enclosure. Features include the following:

1. Interrupting Capacity: 200,000 A, minimum.
2. Fuse Ratings and Characteristics: As recommended by capacitor manufacturer.
3. Neon Indicator Lamp for Each Fuse: Connect to illuminate when fuse has opened, but is still in place, and locate so it is visible from outside the enclosure.

F. Discharge Resistors: Factory installed and wired. Resistors may be omitted if permitted by the OBO Electrical Code.

G. Enclosure: NEMA 250, steel or aluminum, arranged to contain the fluid leakage from capacitor cells; factory equipped with mounting brackets suitable for type of mounting indicated.

1. Indoor Enclosures: NEMA 250, Type 12 or as indicated.
2. Outdoor Enclosures: NEMA 250, Type 4, equipped with watertight conduit connections.

2.2 FIXED CAPACITORS

A. Description: Integrally fused, unless otherwise indicated.

B. Internal Wiring: Factory wired, ready for field connection to external circuits at a single set of pressure terminals.

2.3 AUTOMATIC POWER FACTOR CORRECTION UNITS

A. Comply with NEMA ICS 2.

B. Description: Capacitor banks, contactors, controls, and accessories factory installed in independent enclosures and motor-control center, with a connection to motor-control center bus. Units include a separately mounted current transformer to sense current in the power circuit being corrected and to provide input to unit controls.

C. Performance Requirements: Controls permit selection of a target power factor, adjustable to any value between unity and 0.95 lagging. Controls continuously sense the power factor on circuits being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a contractor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Switch only one capacitor bank at a time.

D. Install the capacitive kVAR throughout the distribution system by placing capacitors at major load centers such as motor control centers or large motors, rather than to concentrate it all at the service entrance. The power factor shall be corrected to 0.95 lag unless a higher level of correction is required to avoid power factor charges by the power company.

E. Controls: Solid-state, microprocessor-based controls, including the following:

1. Undervoltage relay that interrupts capacitor switching and disconnects capacitors for power supply interruptions longer than 15 minutes.
2. "Advance" and "Retard" push buttons on the control panel to permit manually controlled capacitor-bank switching.

F. Contactors: Three pole; rated for the repetitive high-inrush-switching duty in the capacitor application.

G. Buses: Plated copper.

H. Fuses for Protection of Capacitor Banks: Rated to protect contactor, interconnecting wiring, and capacitors.

I. Inductors: Air-core-type, connected in capacitor circuits; rated to limit switching surges to within contactor ratings.

J. Precharge Capacitor Circuit: Resistive, precharge circuit to charge capacitors prior to switching and to limit switching surges to within contactor ratings.

K. Mechanical Bracing for Current-Carrying Parts: Adequate to withstand the maximum fault current to which they may be exposed.

L. Identification of Energized Capacitor Banks: LED indicating lamps on front panel.

M. Enclosure Access: Steel or aluminum, with hinged door and hand-operated catch. Door shall be interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.

N. Local Display: LED or liquid-crystal digital type, mounted in door of enclosure, indicating the following:

1. Target and actual power factors accurate to plus or minus 1 percent of reading.
2. Steps energized.
3. Step reconnection delay.
4. Real and reactive currents.
5. Voltage THD.
6. Alarm codes.

O. System Alarms: Alarm relay and local display indication of the following conditions:

1. Low power factor.
2. Leading power factor.
3. Frequency not detected.
4. Overcurrent.
5. Overvoltage.
6. Overtemperature.
7. Excessive voltage THD.
8. Capacitor overload.
9. Loss of capacitance.

P. Current Transformer: Type, configuration, and ratio to suit sensing and mounting conditions.

Q. Main Circuit Breaker: Operable from outside the enclosure to disconnect the unit.

1. Operating handle can be padlocked.

R. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with electrical power monitoring and control network.

Communication module shall have capability to transmit the following data to remote monitoring devices:

1. System in alarm.
2. Power factor set-point.
3. Corrected power factor.
4. Number of capacitor steps activated.

S. Surge Protective Devices: Provide surge protective devices with “sine wave tracking” capability to minimize equipment damage. Maximum lead length of surge protective device is 460 mm.

2.4 FACTORY FINISH

A. Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.

2.5 SOURCE QUALITY CONTROL

A. Factory test power factor correction equipment before shipment. Comply with NEMA CP 1. Include the following:

1. Routine capacitor production tests, including short-time overvoltage, capacitance, leak, and dissipation-factor tests.
2. Functional test of all operations, controls, indicators, sensors, and protective devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install freestanding equipment on concrete bases. Cast-in-place concrete is specified in Section 033000 “Cast-in-Place Concrete.”

B. [Comply with mounting and anchoring requirements specified in Division 26 Section on Vibration and Seismic Controls for Electrical Systems.]

C. Maintain minimum workspace according to manufacturer's written instructions.

D. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.

E. Identify components according to Division 26 Section on Identification for Electrical Systems.

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each power factor correction capacitor element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect capacitors, wiring, components, connections, and equipment installation.
2. Assist in field testing of equipment including pretesting and adjusting of automatic power factor correction units.
3. Report results in writing.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Capacitors and Reactors - Capacitors." Certify compliance with test parameters.

E. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.3 ADJUSTING

A. Adjust for optimum automatic power factor correction.

3.4 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean components internally, on completion of installation, according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain automatic power factor correction units. Demonstrate method of determining optimum settings for system controls.

B. Conduct a minimum of two hours' training.

END OF SECTION 263535

SECTION 263552 – LOW-VOLTAGE AUTOMATIC VOLTAGE REGULATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes low-voltage (LV) Automatic Voltage Regulators (AVR).

B. Related Sections include the following:

1. Section 260508 "Common Work Results for Electrical Systems" for facility voltages.
2. Section 260518 "Low-Voltage Electrical Power Conductors and Cables."
3. Section 260525 "Grounding and Bonding for Electrical Systems" for personnel safety and to provide a low impedance path for possible ground fault currents.
4. Division 26 Section on raceways and boxes" for conduits and outlet boxes.
5. **[Division 26 Section on vibration and seismic controls for electrical systems.]**
6. Section 260573 "Overcurrent Protective Device Coordination Study."
7. Section 260815 "Field Testing and Inspection of Electrical Systems."
8. Section 260915 "Electrical Power Monitoring."

1.2 PERFORMANCE REQUIREMENTS

A. AVR system shall be commercially available. LV AVR shall be standard products of manufacturer and shall be manufacturer's latest design that complies with this Section. The automatic voltage regulators provided under this Section shall be products of the same manufacturer. Units with proprietary manuals or schematics that cannot be openly provided to the Government and any AVR maintenance firm selected to work on AVR system are not allowed.

B. Performance Characteristics:

1. Input Voltage: System voltage shall be typical of, but not limited to, the following: Site Distribution Voltage and frequency, three-phase, four wire, grounded. AVR shall produce rated output voltage when input voltage is varied plus **[XX]** or minus **[XX]** percent or greater.
2. Surge Protection: Protect AVR with surge suppressors rated for expected transients based on local conditions. <**Insert data from local power quality survey.**>
3. Input Current Distortion: AVR shall not produce negative effects on overall power system due to harmonic effects.
4. Output Voltage:

   a. Corrected voltage shall not exceed maximum of **[0.5]** percent of nominal voltage.
   b. AVR shall respond to any line voltage variation in less than 5.0 cycles and shall complete correction of voltage within 2 seconds while operating under any line or load condition and with any power factor.

5. Efficiency: Minimum efficiency of **[98]** percent.
6. Overload/Overcurrent: Units shall be capable of sustaining overload/overcurrent without damage.
7. Provide phase loss and phase rotation protection; this protection shall open output and bypass breakers. These breakers shall automatically reclose with time delay (adjustable 0-30 min) after phase correction or restoration.

C. Product Selection for Restricted Space: Drawings indicate maximum dimension for automatic voltage regulator, including clearances. Select product to conform to indicated minimum clearance dimension.

D. Qualification data for firms and persons specified in Article on QUALITY ASSURANCE.

1. Support Services Vendor: Identify vendor firm name and contact, location, distance from project, years and servicing product line.

E. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. The ratings for AVR and enclosures shall conform to local site ambient environment conditions. AVR shall operate satisfactorily from no load to rated full load. Provide all necessary heating, cooling, ventilation, air conditioning and thermostat systems necessary to facilitate full load operation of AVR.
2. Conditions:

a. Ambient Temperature: **[10 deg C to 50 deg C]**.
b. Altitude: Derating of equipment where and as required for altitude above sea level.
c. Relative humidity: Up to 100 percent non-condensing.

F. Corrosion Resistance: **[XX]**.

1.3 SUBMITTALS

A. Product Data - General: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Scaled drawings of enclosure outline including front, top, side views, and overall dimensions. Indicate external power and control wiring and cable connections. Indicate conduit entry and exit locations.
2. Single line, schematic, and wiring diagrams.
3. Details of input and output circuit breakers, contactors, rectifiers, surge protectors, and control devices.

C. Product Certificates:

1. For surge protective devices, signed by product manufacturer certifying compliance with the following standards:

    a. UL 1449.

2. For AVRs:

    a. Document that AVRs are designed for connection to non-linear loads typically encountered in commercial buildings.

D. Calculations to determine if installation of individual cooling fans are required above each phase for enclosures in relation to environmental conditions identified in Article on PERFORMANCE REQUIREMENTS.

E. Qualification Data:

1. For testing agency.
2. For professional engineer for power quality analysis.
3. Certification of experience identified in Article on QUALITY ASSURANCE.

    a. Certification shall state that manufacturer is experienced in manufacturing and testing AVRs of equivalent kVA rating.
    b. Document experience with AVRs in various environmental conditions including exterior green space, warehouse, and environmentally enclosed spaces within buildings.

F. [Manufacturer Seismic Qualification Certification: Submit certification that voltage regulator, accessories, and components will withstand seismic forces defined in Division 26 Section on vibration and seismic controls for electrical systems when anchored to concrete base. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. Term "withstand" means "unit will remain in place without separation of any parts from device when subjected to seismic forces specified and unit will be fully operational after seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.]

G. Field quality-control test reports, including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Include voltage monitoring and adjusting.
4. Failed test results and corrective action taken to achieve requirements.

H. Operation and Maintenance Data:

1. Submit voltage regulator operation and maintenance manuals in accordance with Division 01 Section "Systems Manual and O&M Data."
2. In addition to general information manufacturer's information on operation and maintenance, include the following information on voltage regulator:

   a. "One-line diagram" from service entrance to low voltage utilization panel or point.
   b. Weatherproof, tear-resistant plastic data sheet with operating instructions for each unit including startup and shutdown procedures.
   c. Routine and field acceptance test reports.

3. Preliminary Operation and Maintenance Manuals: Prior to scheduling Field Performance Tests, submit two copies of Preliminary Operation and Maintenance Manuals as well as two complete sets of drawings and schematics, and obtain acceptance by Project Director/COR.
4. Spare Parts List: Furnish recommended manufacturer's spare parts list and schedule of prices for each type of AVR and other equipment specified in this section. This list shall include the following:

   a. Power semi-conductors.
   b. Power filter capacitors.
   c. Logic cards and boards.
   d. Output switching modules.
   e. Fuses.
   f. Indicator lamp/LED.
   g. Ventilation system filters.

I. Training Plan: Submit in accordance with Division 01 Section "Demonstration and Training."

1.4 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code (NFPA 70 "National Electrical Code" as amended by OBO).

1. Electronic Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

B. Manufacturer Qualifications: Minimum of 15 years' experience in design, manufacturing, and testing of low-voltage automatic voltage regulators at the equivalent kVa and voltage ratings for direct connection to electrical systems based on local utility voltage and frequency.

1. The manufacturer shall be experienced in producing units for installation in permanent buildings in environmentally closed spaces and in weatherproof enclosures.

C. AVR shall be UL or CE certified.

D. Comply with FCC Regulations: Part 15, Subpart J, "Emission Limits for Class A Devices."

E. Support Service Capability: Manufacturer approved support services vendor to start-up AVR, and available to provide ongoing maintenance services. Vendor shall be located within 1500 km (1000 miles) of project site. Vendor shall have performed these services on this product line for at least five.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Ship low voltage enclosure completely factory assembled with lifting provisions. Mount unit on steel channel skid with lifting provisions.

B. Temporary Heating: If applicable, apply temporary heating for associated storage area prior to installation. Apply temporary heat according to manufacturer's written instructions within enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB; PCS100 AVC (Active Voltage Conditioner).
2. Eaton – Culter Hammer; SRT2 (Sage Ride Through Voltage Conditioner).
3. Utility Systems Technologies, Inc.; Sure-Volt Power Conditioner (Voltage Regulator).
4. Omniverter **[Digital AVR][Digit@l-M+Voltage Stabilizer]**.

2.2 LOW-VOLTAGE AUTOMATIC VOLTAGE REGULATORS

A. Provide voltage regulator consisting of modular construction components to accomplish low voltage regulation, with input/output devices and ancillary control devices.

B. External Bypass Configuration: Provide components and configuration which will facilitate external bypass operation to supply load while enabling safe and complete inspection, maintenance, and removal of all AVR components during system’s lifetime.

C. Monitoring and Control Panel: Provide AVR with control panel equipped with the following controls, indicators, instrumentation, data logging, diagnostics, and alarm functions:

1. Controls:

   a. Lamp/ Light Emitting Diode (LED) Test: Push-to-test button or switch to test indicator lamps/LEDs.
   b. Alarm Silence: Switch that shall disable audible alarm.
   c. Alarm Reset: Pushbutton to silence audible alarms.
   d. Output voltage adjustment.

2. Indicators:

   a. Input Power Available: Lamp/LED shall indicate that supply voltage is available.
   b. Output Power On/Off: Lamp/LED shall indicate that AVR output voltage is available.
   c. System Alarm: Lamp/LED shall indicate that problem has been detected.
   d. Audible Alarm.
   e. Remote Alarm: AVR shall have remote alarm in area manned 24-hours.
   f. Instrumentation: Unit shall have true rms metering. Meter shall display all output phase-to-neutral voltages, all output phase-to-phase voltages, and all output per phase current. Meter shall display all output KW, kVA, and power factor.

3. Alarm Annunciator: Unit shall be capable of detecting the following abnormal condition, sounding audible alarm, and illuminating individual indicator lamp/LEDs that are clearly identified:

   a. Output overload.
   b. System alarm.
   c. Overtemperature.

D. Circuit Breakers: Conform to requirements of UL 489 and UL 1066. Units operating at 50 Hz shall be rated for 50 Hz operation, and units operating at 60 Hz shall be rated for 60 Hz operation.

1. Input Circuit Breaker: UL listed input circuit breaker with appropriate frame size. Circuit breakers shall have short-circuit current rating suitable for local system conditions. Input circuit breaker shall be rated to carry maximum rated current at minimum voltage.
2. Output Circuit Breaker: UL listed output circuit breaker with appropriate frame. Circuit breaker shall have short-circuit current rating suitable of **[__ kA]**.

   a. Output circuit breaker shall be mechanically interlocked with AVR external bypass circuit breaker. Interlock scheme shall not require AVR de-energizing to actuate external bypass.

3. Input and Bypass breakers shall be service rated.

   a. Mechanically interlock output circuit breaker with AVR external bypass circuit breaker. Interlock scheme shall not require AVR de-energizing to actuate external bypass.

4. Bypass Circuit:

a. External Bypass: External bypass circuit breaker shall be mechanically interlocked with AVR output circuit breaker. Interlock scheme shall not require AVR de-energizing to actuate external bypass.

5. Scenario with AVR as Part of Service Entrance Equipment: Provide with 4-pole main circuit breaker. This 4 pole main breaker shall be adjustable for under/over voltage, over/under frequency, loss of phase, and phase reversal sensing to trip this breaker when utility service is outside preset tolerance for preset adjustable time delays.
6. All Circuit breakers 1000A and larger shall include electronic LSIG trips.
7. Conform to analysis from Section 260573 "Overcurrent Protective Device Coordination Study."

E. Auto Restart: After total input power outage, unit shall automatically restart and re-energize loads upon restoration of normal power.

2.3 CONTROLS

A. Provide control panel and circuitry. Connect to clearly and permanently labeled terminal blocks located inside AVR's enclosure. Provide circuitry such that indicator lamp/LED information and can be extended from terminals to remote location in future. Control panels shall include the following as a minimum.

1. Indicator lamp/LED showing that unit status (energized or not energized).
2. Indicator lamp/LED showing external bypass status (On or Off).
3. Phase loss and phase rotation alarms.
4. Over temperature alarms.
5. Input and output voltages and currents.
6. System alarm.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall conform to manufacturer's instructions.

B. Clearances: Comply with the OBO Electrical Code.

C. Building Wiring and Conduit: Install wiring and conduit for circuits as specified in Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

D. Posted Instructions: Post startup and shutdown instructions on front of unit using engraved plastic plate. Provide plastic encapsulated schematic diagram attached to inside of unit in clear view of maintenance personnel.

3.2 GROUNDING

A. Comply with the National Electrical Code (NFPA 70) requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

B. Comply with Chapter 2 of the OBO Electrical Code. Refer to Section 260525 “Grounding and Bonding for Electrical Systems” for materials and installation requirements.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Representative: Engage factory-authorized service representative to inspect field assembly and connection of components, and to start up and commission unit.

B. Performance of Acceptance Checks and Tests:

1. Test Objective: To ensure voltage regulators and associated equipment are operational within specified tolerances, comply with Contract Documents, and are suitable for energizing.
2. Test Labeling: Upon satisfactory completion of tests for each unit, attach dated and signed "Satisfactory Test" label to tested component.
3. Schedule tests and provide notification to Project Director/COR at least seven days in advance of test commencement.

C. Checks and Tests: Perform those listed below and those recommended in manufacturer's written instructions. For transformer components of voltage regulators, perform tests according to manufacturer's written instructions and IEEE C57.12.91.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, damage, and deterioration. Verify that temporary shipping bracing has been removed.

   a. Include internal inspection through access panels and covers.
   b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those of UL 486A.

2. Perform functional tests of voltage regulators throughout their operating ranges. Check voltage tolerance, correction speed, and harmonic content of output. Test each monitoring and alarm function.
3. Test Failures: Correct deficiencies identified by tests and retest. Verify that equipment complies with specified requirements.

D. Initial Inspection and Tests:

1. Compare equipment nameplate information with specifications and approved shop drawings.
2. Inspect physical and mechanical condition.
3. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrating torque-wrench method, or performing thermographic survey.

4. Perform specific inspections and mechanical tests as recommended by manufacturer.
5. Verify correct equipment grounding.
6. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
7. Verify proper secondary phase-to-phase and phase-to-neutral voltage after energizing and prior to connection to loads.

E. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion, but not more than six months after Final Acceptance of the Voltage Regulator.

1. During period of normal load cycles as evaluated by Project Director/COR, perform thirty days of three-phase voltage recording.
2. If tests results are unacceptable, perform corrective actions as appropriate.
3. After correction actions have been performed, repeat monitoring until satisfactory results have been obtained.
4. Prepare written report covering monitoring and corrective actions performed.

F. Power Quality: During installation of electrical service equipment, monitor and record power quality using PowerSight PS4000 at location to determine necessity, for a minimum of 30 days.

3.4 DEMONSTRATION

A. Engage factory-authorized service representative to train Government maintenance personnel to adjust, operate, and maintain voltage regulators.

B. Coordinate with Project Director/COR and post Facility Manger to identify staff, including locally employed staff (LES) maintenance personnel, who may access AVR.

C. Train Government maintenance personnel in the following:

1. Safety precautions.
2. Features and construction of project equipment.
3. Voltage adjustment procedures.
4. Routine testing and monitoring operations.
5. Interpretation of readings of indicating and alarm devices.
6. Routine inspection procedures.
7. Routine maintenance.
8. Access control panel to maintain an operations log as specified by OBO Facility Management.
9. Remove and replace control panel.
10. Bypass, isolate, de-energize, and lock-out the AVR. This will include an explanation and demonstration using the required safety equipment to isolate and de-energize the AVR and verify that it is de-energized.
11. Clean the connections and conductors on a basis approved by OBO Facility Management.
12. Review data in maintenance manuals, including written Standard Operating Procedures to (SOP) accomplish the above tasks.

D. Schedule training with Project Director/COR with at least seven days' advance notice.

END OF SECTION 263552

SECTION 263554 – MEDIUM-VOLTAGE AUTOMATIC VOLTAGE REGULATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes medium-voltage automatic voltage regulators (AVR).

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical Systems” for facility voltages.
2. Section 260525 on “Grounding and Bonding for Electrical Systems.”
3. **[Division 26 Section on vibration and seismic controls for electrical systems.]**
4. Division 26 Section on identification for electrical system.
5. Section 260573 “Overcurrent Protective Device Coordination Study.
6. Section 260815 “Field Testing and Inspection of Electrical Systems.”
7. Section 260915 “Electrical Power Monitoring.”
8. Section 264315 “Surge Protective Devices” for surge suppressors applied independent of voltage regulators and power distribution units.

1.2 SYSTEM DESCRIPTION

A. Medium Voltage AVR system consists of three units of automatic single phase step voltage regulators connected in delta bank configuration, installed in deadfront weather resistant pad mounted enclosure with insulated bus bars. AVR system shall provide minimum of plus/minus 15 percent regulation in the closed-delta configuration.

1.3 SUBMITTALS

A. Product Data - General: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For station-class surge arrestors, signed by product manufacturer certifying compliance with the following standards:

1. ANSI C62.11 (IEEE Std. C62.11).

C. Environmental Calculations: Submit calculations to determine if the installation of individual cooling fans above each phase for enclosures is required.

D. Qualification Data: For testing agency.

E. [Manufacturer Seismic Qualification Certification: Submit certification that medium voltage regulator, accessories, and components will withstand seismic forces defined in

Division 26 Section "Vibration and Seismic Controls for Electrical Systems" when anchored to concrete base. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. Term "withstand" means "unit will remain in place without separation of any parts from device when subjected to seismic forces specified and unit will be fully operational after seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.]

F. Field quality-control test reports, including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

G. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.

1. Include safety Standard Operating Procedures (SOP), including de-energization and isolation procedures.

1.4 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code (NFPA 70 “National Electrical Code” as amended by OBO).

1. Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

B. Comply with IEEE C2.

C. Comply with FCC Regulations: Part 15, Subpart J, "Emission Limits for Class A Devices."

D. Comply with ANSI Standard C57.15.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Ship pad-mounted medium voltage enclosure completely factory assembled with lifting provisions. Mount unit on steel channel skid with lifting provisions.

B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

1.6 PROJECT CONDITIONS

A. Product Selection for Restricted Space: Drawings indicate minimum clearance for construction, operation, and maintenance for automatic voltage regulator, including clearances. Select product to conform to indicated minimum clearance dimension.

B. Environmental Limitations: Voltage regulators shall withstand the environmental conditions identified below without mechanical or electrical damage or degradation of performance capability. Ratings for AVR and enclosure shall conform to local site ambient environment conditions. AVR shall operate satisfactorily from no load to rated full load based on local site conditions. Provide all necessary heating, ventilation, and thermostat systems necessary to facilitate operation of AVR.

1. Ambient Temperature: **[10 deg C to 50 deg C.]**
2. Altitude: Derate equipment where and as required for altitude above sea level.
3. Relative humidity: Up to 100 percent non-condensing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the following:

1. Cooper Industries; Cooper Power Systems Division.
2. GE Electrical Distribution & Control.
3. Siemens Energy & Automation, Inc.

2.2 MEDIUM VOLTAGE SINGLE-PHASE AUTOMATIC VOLTAGE REGULATOR (AVR)

A. General

1. This specification covers electrical, mechanical and safety features and characteristics of outdoor, medium voltage single-phase, oil-immersed, step-type automatic voltage regulators.
2. Voltage regulators shall be completely self-contained and provide plus or minus 10 percent in 32 steps of approximately 5/8 percent each. Forced air (FA) ratings are not acceptable.
3. Regulators furnished under this specification shall be designed, manufactured and tested in accordance with ANSI Standard C57.15.
4. Nominal voltage rating shall match host country voltage.

5. Furnish unit with ANSI Type II mineral oil per ASTM D-3487, or furnish with less-flammable type, fire-resistant biodegradable seed oil; Basis of Design, Envirotemp FR3. Oil shall contain less than one part per million PCBs at time of manufacture; this shall be so stated on regulator nameplates.

B. Construction:

1. Design regulators such that they can be partially or completely untanked for inspection and maintenance without disconnecting any internal electrical or mechanical connections. Provide military specification-style quick disconnect with solid-state automatic current transformer shorting device.
2. Tap-Changing Mechanism: Motor-driven, quick-break type, completely oil-immersed.
3. Regulator shall be of sealed-tank construction to permit operation at 65 deg C rise without increasing oxidation rate of oil. Provide pressure-relief device which vents at approximately 27.5 kiloPascals.
4. Paint external parts of tank and control enclosure ANSI #70 gray. Prime or paint inside of tank and bottom of cover.
5. Provide regulator coil with thermally upgraded insulation to permit operation of regulator up to 65 deg C rise without loss of life to insulating system. At 65 deg C rise, regulator shall provide 12 percent extra current capacity over base current rating. Use suitably patterned, epoxy-coated insulation paper in winding. Prior to assembly of core and coil assembly, bake winding with sufficient mechanical pressure exerted on winding to assure complete bonding of insulation to improve its short-circuit current withstand capabilities.
6. Series winding may be aluminum. Shunt winding shall be copper.

C. External Features:

1. BIL rating of bushings shall be compatible with BIL of regulator. Mark bushing designations (S, L and SL) on regulator cover adjacent to bushings. S, L and SL bushings shall be interchangeable with each other.
2. Provide each bushing with deadbreak elbow rated at system voltage.

   a. Elbow is required on each side of cable from regulator bushing to each bypass and on each phase disconnect switch.

2. Provide regulators with external metal oxide varistor (MOV) bypass arrester connected across series winding.
3. Provide external oil sight gauge which indicates oil level at 25 deg C ambient temperature.
4. Provide external position indicator to indicate tap changer position. Mount position indicator above oil level, and slant downward at 45-degree angle for ease of reading from below when regulator is pole mounted.
5. Unit shall be capable of additional current carrying capabilities at reduced regulation as indicated in Table 2.2, “Current Carrying Capabilities”:

TABLE 2.2: CURRENT CARRYING CAPABILITIES

REGULATION (Percent)	CURRENT (Percent of 55 deg C Rating)

±10.0	100
±8.75	110
±7.5	120
±6.25	135
±5.0	160

6. Provide mounting bosses for addition of lightning arresters adjacent to source (S), load (L) and source-load (SL) bushings. Fully weld bosses around their circumference; spot welding is not acceptable.
7. Provide all regulators with 25 mm drain valve having sampling device and 25 mm upper filter press connection.
8. Provide handhole with cover on top of regulator for inspection purposes and for access to terminals used for reconnection of regulators for lower-voltage operation.
9. Provide each unit with base suitable for securing them to concrete pad. Provide each unit with two ground pads located diagonally opposite from each other. Each pad shall have two 16 mm ground provisions. Locate grounding provisions near or on the base of unit.
10. Provide each regulator with two laser-etched nameplates, one mounted on control enclosure and other mounted on regulator tank. Nameplates shall have manufacturer code and serial number barcoded with "3 of 9" coding, using 6 mm minimum height.
11. Input switches shall consist of 3 pole fused and 3 pole un-fused disconnect switches to provide input power to AVRs and output/by-pass switches as depicted in AVR system connection diagram.
12. Output-by-pass switches shall consist of 3 pole fused and 3 pole un-fused disconnect switches which shall be interlocked to allow operator to bypass AVR bank but still provide utility power to site.

D. Regulator Control:

1. Mount regulator control panel in weather-resistant enclosure capable of being padlocked. Provide control enclosure with external 13 mm - 13 UNC welded ground boss.
2. Locate control panel in location near regulator enclosure but away from any arc fault hazards.
3. Control panel shall be hinge-mounted and designed for easy inspection and replacement. Construct front panel assembly to provide direct control interchangeability without requiring removal of control enclosure. Provide visible means to de-energize control and to short current transformer prior to control testing or removal.
4. Install accessory doors for control panels on short and long boxes; open boxes with exposed components or wiring are not acceptable.
5. Color code or label all leads in control for easy identification.
6. Conformal coat printed circuit boards for fungi and moisture protection.
7. Provide ratio correction transformer inside control enclosure for easy access to fine voltage adjustment. Clearly identify ratio correction taps and corresponding system voltage on regulator nameplates.
8. Regulator control panel shall include the following items:

a. Three-position voltage source switch, labeled INTERNAL-OFF-EXTERNAL, which allows regulator to be operated from internal potential source, operated from external source, or de-energized.
b. Three-position AUTOMATIC-OFF-MANUAL control switch, which allows automatic or manual operation of regulator, or allows control to be turned off. Supervisory motor control shall be permitted only when switch is in AUTOMATIC position.
c. Spring-loaded three-position manual RAISE-LOWER toggle switch, which shall only be active when AUTOMATIC-OFF-MANUAL switch is in manual position.
d. Position indicator drag hand reset switch, located on front panel.
e. Neutral indicating light which is actuated via tap changer to provide neutral indication.
f. Six-digit operations counter which counts every tap change.
g. Separate motor and panel fuses which are replaceable from front panel. Clearly mark fuse size below each fuse. Provide one set of spare fuses in control enclosure.
h. Provide means to indicate whether voltage is inside or outside set voltage band.
i. Voltage test terminals which connect to load side (L bushing) of regulator.
j. External voltage source terminals which allow control and tap changer operation from external 240 vac source. Provide means to prevent energizing high voltage bushings from external source.
k. Control knob locking devices which prevent inadvertent adjustment of settings. Locking device shall be operable with flat head screwdriver.

9. Control shall have provisions for setting the following parameters:

a. Set voltage shall be adjustable from 210 to 270 volts in increments no larger than 2 volts.
b. Set voltage bandwidth shall be adjustable from 1 to 6 volts in increments no larger than 0.5 volts.
c. Time delay shall be adjustable from 10 to 120 seconds in increments of 10 seconds.
d. Line drop compensator settings consisting of resistance and reactance that shall be individually adjustable from 0 to 24 volts. A means shall be provided to set polarity of these settings.

10. Control shall have provisions to allow remote override of regulator operation via discrete (analog) supervisory control. Terminals shall be provided on back panel as follows:

a. For motor raise: Two terminals for normally-open, momentary-close contacts.
b. For motor lower: Two terminals for normally-open, momentary-close contacts.
c. For auto inhibit: Two terminals for normally-closed, latch-open contacts.

E. Series Surge Arresters

1. Equip each regulator with a bypass arrester connected across series winding between source (S) and load (L) bushings. Bypass arrester shall limit voltage developed across series winding during lightning strikes, switching surges, and line faults.
2. Provide station class lightning arresters with adequate ratings for voltage application.

F. Shunt Arresters

1. Equip each regulator with shunt arresters for protection of shunt winding. Mount shunt arrester directly on tank and connect between load bushing and ground.
2. Provide shunt arrester between each source bushing and ground.
3. Provide station class lightning arresters with adequate ratings for voltage application.

G. AVR Configurations: Without exception, all medium voltage automatic voltage regulators shall be delta connected.

H. General Accessories:

1. Manual disconnect and bypass switch.
2. Thermostatically controlled heater assembly to reduce moisture in areas of high humidity. Heater assembly shall include an ON-OFF switch. In ON position, thermostat in heater assembly shall activate heater at approximately 30 deg C and turn it off at approximately 40 deg C.
3. Series and shunt arresters.
4. Fiber optic interface board for digital communication.
5. Internal differential potential transformer for complete power flow with metering, provide appropriate control module.
6. Data reader.
7. 240 volt external source connections
8. Cooling fans.
9. Elevating structure.
10. Extra long control cables.

2.3 SAFETY ACCESSORIES

A. Supply the following accessories to assist in safely de-energizing AVR and transformer:

1. Two live–line tools conforming to ASTM F711; one 1200 mm (4 foot) and one 1800 mm (6 foot) in length.
2. Non-contact voltage proximity detector. Detector shall have both audio and visual alerts and warning indicators. Detector shall be instrument rated for AVR and transformer voltages. Detector shall be compatible with live-line tool.
3. Two pair voltage-rated (VR) gloves and leather protectors conforming to ASTM D120 Class 2 (voltage rating of 17,000 AC and 25,500 DC); one pair glove size 8.5, and one pair glove size 9.5. Provide canvas bags for glove storage.
4. Two sets VR rubber sleeves similar voltage rating as VR gloves, with canvas storage bags.
5. ASTM F1506 approved arc flash suit NFPA Hazard class 4, size large.
6. Two sets safety grounds capacity rated for application conforming to ASTM F855. Ground cluster connectors shall acceptably secure clamp onto phase conductor and ground conductor.
7. Retrieval stick conforming to ASTM F711; 1800 mm (6 foot) in length.

2.4 PAD MOUNTED MEDIUM-VOLTAGE ENCLOSURE

A. Construction:

1. Enclosure Sections:

   a. Input Section: Section shall contain fused disconnect switch to serve as AVR system incoming/disconnect switch, and unfused disconnect switch for AVR system by-pass power.
   b. Output Section: Section shall contain disconnect and by-pass switches for each of single phase step voltage regulators; refer to Paragraph on "External Features" within Article on MEDIUM VOLTAGE SINGLE-PHASE AUTOMATIC VOLTAGE REGULATORS for requirements on these switches. Section shall also contain AVR system by-pass disconnect and output overcurrent protection.

2. Tamper resistant and weather resistant, with no exposed screws or bolts.
3. Enclosure Material: Minimum 3 mm mild steel.
4. Bolted construction rather than welded construction, such that enough of roof and walls of enclosure can be easily unbolted and removed to allow for use of overhead lifting device to un-tank each regulator for inspection and for replacement of internal contacts and parts. Follow manufacturer's recommendations for manner of implementing these features.
5. Enclosure shall utilize welded spreader frames at top and bottom.
6. Panels and doors: Formed edges.
7. External fasteners: Stainless steel.
8. Roof: Domed to shed water.
9. Infrared Windows: Viewing windows for infrared inspections, with doors and enclosure closed, of cable connections, bus bar connections, and control or switch devices and connections.

   a. Construct in accordance with IEEE C.37.20.2 a.3.6 for Viewing Panes in MV Equipment, Greater than NEMA 4 open. Conform to NFPA 70E, arc flash, and safe and efficient thermography practices.
   b. Coordinate IR Window installation with arc flash hazard at equipment.
   c. Size and location of IR window shall ensure maximum coverage and therefore maximum efficiency to inspect through window.

B. Doors:

1. Provide doors for each of section of enclosure and one door for each voltage regulators. Size doors to allow for removal of switches, fused and the single phase voltage regulator.
2. Door Hinge: Minimum 9.5 mm diameter stainless steel.
3. Each door shall have positive three-point latching mechanism.
4. Door Handles: Capable of accepting a padlock handle.
5. Provide features to preclude accidental contact of live parts when doors are open.

C. Venting:

1. Provide adequate venting to dissipate the heat of enclosed regulator equipment.

a. Fused transfer/bypass switches do not require ventilation and shall be in non-ventilation section to prevent entrance of dust.

2. Cover vent openings on inside with perforated aluminum screen or filters to mitigated dust from migrating into equipment.

2.5 SOUND LEVEL

A. General: Fully assembled products in this Section have a minimum of 3 dB less than maximum sound levels prescribed for transformers of corresponding ratings when factory tested according to IEEE C57.12.91.

2.6 FINISHES

A. Outdoor Units: Comply with ANSI C57.12.28, "Enclosure Coating System" Article.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arrange equipment to provide adequate spacing for access and for cooling air circulation.

B. Clearances: Comply with the OBO Electrical Code. Locate medium voltage regulator equipment to provide minimum of 3 meter (10-ft) clearance space between enclosure cabinet access panel and doors, and enclosing security fence or other equipment.

C. Identify equipment and install warning signs according to Division 26 Section on identification for electrical systems.

D. Allow sufficient pad or ground space near medium-voltage AVRs to permit placement of temporary lifting device required for un-tanking.

3.2 GROUNDING

A. Separately Derived Systems: Comply with Chapter 2 of the OBO Electrical Code requirements for connecting grounding and conform to grounding design indicated on Construction Drawings.

1. Voltage Regulator: Connect neutral conductor of voltage regulator output to local grounding electrode.

B. Comply with Section 260525 “Grounding and Bonding for Electrical Systems” for materials and installation requirements.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage factory-authorized service representative to inspect field assembly and connection of components.

B. Test Objective: To ensure voltage regulators and associated equipment are operational within specified tolerances, comply with Contract Documents, and are suitable for energizing.

C. Test Labeling: Upon satisfactory completion of tests for each unit, attach dated and signed "Satisfactory Test" label to tested component.

D. Schedule tests and provide notification to Project Director/COR at least seven days in advance of test commencement.

E. Inspections and Tests: Perform those listed below and those recommended in manufacturer's written instructions. For transformer components of voltage regulators, perform tests according to manufacturer's written instructions and IEEE C57.12.91. Apply safety requirement principles and guidance of NEMA Standard SG-2008 during inspection and testing efforts.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, damage, and deterioration. Verify that temporary shipping bracing has been removed.

   a. Include internal inspection through access panels and covers.
   b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those of UL 486A.

2. Perform functional tests of voltage regulators throughout their operating ranges. Check voltage tolerance, correction speed, and harmonic content of output for stepped changes in source voltage at 35, 70, and 100 percent of rated load. Test each monitoring and alarm function and coordinate with electrical power monitoring system. Include as minimum the following points to monitor.

   a. All load and source power meter data including load voltage, current, and power
   b. Load tap contact position
   c. Load and source voltage THD
   d. Load current THD
   e. Load tap contact operational counter
   f. Manual – automatic tap contact position
   g. Preventive maintenance tapping (PMT) by automatically operating the tap-changer based on user-configured parameters. The duty cycle monitor calculates the amount of life used for each arcing surface contact on the AVR tap changer to assist in scheduling preventative maintenance

F. Test Failures: Correct deficiencies identified by tests and retest. Verify that equipment complies with specified requirements.

3.4 CLEANING AND ADJUSTING

A. On completion of installation, cleaning, and testing, touch-up scratches and mars of finish to match original finish.

B. Adjust voltage regulators to provide optimum voltage at equipment served throughout normal operating cycle of facility. Record input and output voltages and adjustment settings for submission with test results.

3.5 DEMONSTRATION

A. Engage factory-authorized service representative to train Government maintenance personnel to adjust, operate, and maintain voltage regulators.

B. Coordinate with Project Director/COR and post Facility Manger to identify staff, including locally employed staff (LES) maintenance personnel, who may access AVR.

C. Train Government maintenance personnel in the following:

1. Coordinate training on safety precautions and use of medium-voltage safety accessories with requirements in Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety,” and Section 260573 “Overcurrent Protective Device Coordination Study.” Apply safety requirements of NEMA standard SG-2008 during all instruction on, and demonstration of, supplied equipment.

    a. De-energizing procedures to safely de-energize, isolate and lock-out the regulators prior to any maintenance or repair work. Standard Operating Procedures described in O&M Data Manual.

2. Features and construction of project equipment.
3. Voltage adjustment procedures.
4. Routine testing and monitoring operations.
5. Changing to AVR bypass configuration.
6. Interpretation of readings of indicating and alarm devices.
7. Routine inspection procedures.
8. Access control panel to maintain an operations log in accordance with procedures of OBO/OPS/FAC.
9. Remove and replace control panel or components.
10. Clean connections and conductors on basis identified by OBO/OPS/FAC considering input from manufacturer.
11. Review data in maintenance manuals, including written Standard Operating Procedures (SOP) to accomplish the above tasks.

D. Schedule training with Project Director/COR with at least seven days' advance notice.

END OF SECTION 263554

SECTION 263600 – TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switch.
2. Remote annunciation system.

B. Related Sections include the following:

1. Section 213115 "Fire Pump Assemblies" for automatic transfer switches for fire pumps.
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety,” including electrical safety accessories.
3. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
4. Section 260525 “Grounding and Bonding for Electrical Systems.”
5. Section 260573 “Overcurrent Protective Device Coordination Study.”
6. Section 260815 “Field Testing and Inspection of Electrical Systems.”
7. Section 260915 “Electrical Power Monitoring.”
8. Section 262325 “Power Sequence of Operation.”
9. Section 263214 “Engine Generators.”

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For manufacturer and testing agency.

E. Field quality-control test reports: Indicate and interpret test and inspection results for compliance with.

F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
3. Include safety Standard Operating Procedures (SOP), including de-energization and isolation procedures.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing emergency maintenance and repairs.

B. Manufacturer approved support services must be provided within [24][48] hours.

C. Testing Agency Qualifications: Testing agency as that is member company of the InterNational Electrical Testing Association (NETA), or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA, the NRTL, or the National Institute for Certification in Engineering Technologies (NICRT), to supervise on-site testing specified in this Section.

D. Source Limitations: Obtain automatic transfer switch, bypass/isolation switch, nonautomatic transfer switch, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.

E. Comply with NEMA ICS 1.

F. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008, unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES (ATS)

A. Open-transition transfer switch operation is the OBO standard. Use of closed-transition transfer switch is not permitted.

B. [Comply with Level 1 equipment according to NFPA 110.]

C. [Comply with NEMA 250, type 12 default enclosure for generally dusty environments.]

D. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is the same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

F. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

G. Digital Communications Interface: Matched to capability of remote annunciator or annunciator and control panel.

2.2 AUTOMATIC TRANSFER-SWITCH FEATURES

A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent. Provide over/under voltage and frequency sensing for all generator transfer switches to initiate generator start and transfer of power.

B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals.

C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes; factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

E. Test Switch: Simulates normal-source failure.

F. Switch-Position Pilot Lights: Indicate source to which load is connected.

G. Source-Available Indicating Lights: Supervise sources via transfer-switch, normal- and emergency-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

H. Unassigned Auxiliary Contacts: Two normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

J. Engine Starting Contacts: One isolated, normally closed and one isolated, normally open, rated 10 A at 32-V dc minimum.

K. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
2. Push-button programming control with digital display of settings.
3. Integral battery operation of time switch when normal control power is not available.

2.3 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Annunciation includes the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communications link.
5. Remote control.

B. Annunciator Panel: LED, LCD or vacuum fluorescent type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.
5. Remote control.

2.4 AUTOMATIC TRANSFER SWITCHES

A. General Purpose Automatic Transfer Switch: (GP-ATS): Automatic Transfer Switch (GP-ATS) shall be 4-pole bypass isolation type transfer switch and have a continuous current rating equal to or greater than the prime current rating of the genset. Switch configuration shall “break” before “make” arranges such that all four poles open and close simultaneously and shall be mechanically interlocked to prevent simultaneous closing of normal and emergency contacts. The main switch contacts shall be long life, high pressure, silver alloy, and have separate arcing contact areas. There shall be two sets of form "C" auxiliary contacts (one for each source) rated at 10 amps continuous and [250 V]. The three leads from each set of contacts shall be wired to six terminals on the consumers terminal strip (see subpara. below on "Terminals (ATS)"). The ATS components shall be in a NEMA 1 enclosure arranged for wall mounting.

1. Sequence of operation (ATS):

a. When the voltage on any phase of the normal source (commercial power) is reduced to 80 percent of rated voltage (adjustable from 75 percent to 98 percent of pickup voltage) for more than 30 seconds (adjustable 0 to 60), the starting contacts shall close.
b. When the genset has started and obtained 90 percent of rated voltage (adjustable 85-100 percent) on all phases and rated frequency, the load shall be transferred to the genset after 30 seconds (adjustable 2 to 120).
c. When the normal source has been restored and the voltage of all phases has been within 90 percent of rated voltage (adjustable 85-100 percent) for 15 minutes (adjustable 0 - 30), the load shall transfer to normal power.
d. The genset shall continue to run for 10 (adjustable 1 to 10) minutes before it automatically stops. The system shall now be ready for another failure cycle.

2. Neutral bus (ATS): The neutral bus shall be electrically isolated from the ATS enclosure and shall be rated at full capacity of the switch. There shall be sufficient terminals to

accommodate the load neutral, the normal source neutral, the emergency source neutral, ground electrode conductor, and an equipment bonding jumper.

3. Equipment Ground Bus (ATS): The equipment ground bus shall be electrically bonded to the ATS enclosure. It shall have one terminal sized to accommodate the equipment bonding jumper, and a second terminal sized to accommodate the equipment grounding conductor.
4. Lugs (ATS): All cable terminations for genset (source two), load and normal (source one) power shall have tinned copper lugs sized to accept a conductor one size larger than required for the current rating.
5. Manual Operation (ATS): The ATS shall have a permanently mounted handle capable of operating the switch mechanism to accomplish both a transfer and retransfer of rated load.
6. Controls (ATS): There shall be a three position, key operated switch labeled "TEST", "NORMAL" and "RETRANSFER" located on the enclosure door.

    a. Test position (ATS): In the "TEST" position the genset shall automatically start come up to rated speed and rated voltage, but the ATS shall not transfer the load to the genset.
    b. Normal position (ATS): In the "NORMAL" position the ATS functions in the completely automatic mode.
    c. Retransfer position (ATS): In the "RETRANSFER" position the ATS immediately transfers the load to commercial source bypassing any preset transfer delays.

7. Indicators (ATS): There shall be four indicator lights, properly labeled as to function mounted on the enclosure door. Two of the indicator lights are to be labeled to show the position of the main switch. The other two indicating lights are to be labeled to show the status of the two sources.
8. Terminals (ATS): A terminal strip(s) for customers use, located inside the ATS enclosure, shall be provided to facilitate the interconnection between the transfer switch and the genset. There shall be a minimum of twenty terminal points available for customer use. Three of these terminals shall be wired to each of the two sets of form C contacts from the main switch auxiliary relays; one terminal shall be wired to accept the genset battery B+; one terminal shall be wired to accept the genset battery (B-); and one terminal shall be wired to serve as the remote start signal source for the genset. The remaining terminals will be unused spares.
9. ATS shall be bypass-isolation type for ease of maintenance and testing purposes.

    a. ATS 4-pole: The 4-pole ATS shall have four poles and shall meet all preceding requirements for GP-ATS.
    b. [ATS mounted battery charger where required: There shall be a static battery charger mounted inside the ATS enclosure. This battery charger shall be the temperature compensated constant voltage type rated to match the battery voltage of the genset, with over-current control to limit the output current to 10 amps even when connected to a dead battery. The charger output shall be pre wired to the B+ and B- terminals of the customer terminal strip.]

B. MGP-ATS with Remote Control /Monitor and Mode Selection: Shall be used for the NOB generator. The MGP-ATS shall meet all of the requirements for GP-ATS above except regarding "Configurations," in addition to the requirements of the following paragraphs.

1. Additional Operational Modes: The MGP-ATS shall be a modified GP-ATS. The modification shall include a remote control panel, and provide a means for the operator to select the following operational modes:

    a. Manual mode: In this mode the transfer switch shall not operate automatically. It shall be controlled only by manual operators located on the MGP-ATS local panel or on the MGP-ATS remote control panel.
    b. Semi-automatic mode: In this mode and with "normal" power being of unacceptable quality, the genset shall automatically start and switch the load from "normal" power to "emergency" power. Switching the load back to "normal" from "emergency" and stopping the genset shall be accomplished by manual control from the MGP-ATS or from the MGP-ATS remote control panel.
    c. Automatic mode: In this mode the transfer switch shall be fully automatic. The transfer switch shall be set for this mode. When "normal" power is of unacceptable quality, the genset shall automatically start, and the load shall be automatically switched to the genset. When the normal power returns to acceptable quality, the load shall be automatically switched to the normal power source.

2. MGP-ATS Remote control/monitor panel: The remote control/monitor panel shall be totally enclosed, NEMA 12 gasketed, and have predrilled wall mounted brackets. It shall be capable of satisfactory operation at any distance up to 300 meters (1000 feet) from the MGP-ATS/genset. All indicating light shall have a means to test for illumination. All devices mounted on the remote control panel shall be properly identified. The panel shall contain, but not be limited to the following:

    a. Genset running light.
    b. Genset failure light and audible alarm (common for all genset failures). After being illuminated, this light shall remain illuminated until it is manually reset at the genset. The audible alarm shall automatically silence after 15 seconds.
    c. A light to indicate that the transfer switch is in the "normal" position.
    d. A light to indicate that the transfer switch is in the "emergency" position.
    e. Remote START-STOP switch to manually START-STOP the genset.
    f. A three position switch (spring return to center "OFF") to effect the operation of the transfer switch to transfer the load from "normal" to "emergency" and from "emergency" to "normal."
    g. Voltmeter, 0 to 600 volt AC (digital or analog, as used on genset control panel).
    h. Seven position voltmeter selector switch connected, identified, and labeled to permit the voltmeter to display the genset phase-to-phase voltage, commercial power phase-to-phase voltage. The seventh position shall turn the voltmeter OFF.
    i. Terminal connection points shall be provided to facilitate interconnection between the MGP-ATS/genset.
    j. Frequency meter to read the frequency of the voltage selected.

3. Changes to genset and GP-ATS: When the MGP-ATS is specified, the genset and GP-ATS shall have interface connections as necessary to accommodate the remote control/monitor and MGP-ATS.

2.5 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.6 SOURCE QUALITY CONTROL

A. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 APPLICATION

A. Four-Pole Switches: Where four-pole switches are indicated, install neutral switching.

3.2 INSTALLATION

A. [Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."]

B. Floor-Mounted Switch: Anchor to floor by bolting.

1. Concrete Bases: 100 mm (4 inches) high, reinforced, with chamfered edges. Extend base no more than 50 mm (2 inches) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Section 033000 "Cast-in-Place Concrete."

C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section "Identification for Electrical Systems."

3.3 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communications requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Government if necessary to accommodate required wiring.

3.4 CONNECTIONS

A. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, pretest, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports.

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microohms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

   a. Verify grounding connections and locations and ratings of sensors.
   b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

C. Coordinate tests with tests of generator and run them concurrently; see Section 263214 “Engine Generators.”

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

3.6 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.

B. Coordinate with Project Director/COR and post Facility Manger to identify staff, including locally employed staff (LES) maintenance personnel, who may access transfer switches.

C. Coordinate this training with that for generator equipment.

D. Train Government maintenance personnel in the following:

1. Coordinate training on safety precautions and use of medium-voltage safety accessories with requirements in Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety” and Section 260573 “Overcurrent Protective Device Coordination Study.”

   a. De-energizing procedures to safely de-energize, isolate and lock-out the transfer switches prior to any maintenance or repair work. Standard Operating Procedures described in O&M Data Manual.

2. Features and construction of project equipment.

3. Routine testing and monitoring operations.
4. Interpretation of readings of indicating and alarm devices.
5. Routine inspection procedures.
6. Access control panel to maintain an operations log in accordance with procedures of OBO/OPS/FAC.
7. Remove and replace control panel or components.
8. Clean connections and conductors on basis identified by OBO/OPS/FAC considering input from manufacturer.
9. Review data in maintenance manuals, including written Standard Operating Procedures to (SOP) accomplish the above tasks.

E. Schedule training with Project Director/COR with at least seven days' advance notice.

END OF SECTION 263600

SECTION 264115 - LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes lightning protection for all buildings on the site.

B. Related Sections include the following:

1. Section 260525 “Grounding and Bonding for Electrical Systems.”
2. Section 270526 “Grounding and Bonding for Communications Systems.”
3. Section 282305 "High-Definition Video System (HDVS)” for exterior mounted elements of the system.

1.2 SUBMITTALS

A. Product Data: For air terminals and mounting accessories.

B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification data of Installer and of Special Inspector for firms and persons specified in the Article on QUALITY ASSURANCE to demonstrate their capabilities and experience. Include data on certification.

D. Rolling Sphere: Demonstrate (e.g., via computer model or calculations) compliance with NFPA 780 rolling sphere method. This requirement applies regardless of building height. Demonstrate that lightning protection is properly located to protect building.

E. Field inspection reports from Special Inspector indicating compliance with specified requirements.

F. Completion Certificate: UL Master Label Certificate.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY.

B. Special Inspector: Experienced in performing special inspections for UL Master Label Certificate.

C. Certified System: System shall conform to complete design of UL Master Label Certified System.

D. Listing and Labeling: In accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input form OBO/PDCS/DE/EE, and marked for indicated use and installation conditions.

E. Lightning Protection shall conform to the requirements of the OBO Electrical Code.

1. System design shall be in accordance with NFPA 780, "Standard for the Installation of Lightning Protection Systems."
2. Conform to UL 96, "Standard for Lightning Protection Components."
3. Conform to UL 96A, "Installation Requirements for Lightning Protection System."

1.4 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. East Coast Lighting Equipment Inc.
2. ERICO International Corporation.
3. Harger
4. Heary Bros. Lightning Protection Co. Inc.
5. Independent Protection Co.
6. Preferred Lightning Protection
7. Robbins Lightning Inc.
8. Thompson Lightning Protection, Inc.
9. <**Insert manufacturer's name.**>

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Roof-Mounting Air Terminals: NFPA Class I, copper, solid or tubular, unless otherwise indicated.

B. Stack-Mounting Air Terminals: Stainless steel.

C. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Section 260525 "Grounding and Bonding for Electrical Systems" and with standards referenced in this Section.

D. Aluminum Conductors: Aluminum conductors are not permitted except at aluminum clad buildings, where applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to NFPA 780. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

B. Conductors Concealment:

1. Conceal the following conductor:

   a. System conductors.
   b. Down conductors.
   c. Interior conductors.
   d. Conductors within normal view from exterior locations at grade within 60 m of building.

2. Do not embed conductors in concrete surrounding PCC.
3. Notify Project Director/COR at least 48 hours in advance of inspection before concealing lightning protection components.

C. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

D. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 18-m intervals.

3.2 CORROSION PROTECTION

A. **[XX]**.

B. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: Engage qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Special inspector shall prepare report and Certification.

END OF SECTION 264115

SECTION 264315 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes Surge Protective Devices (SPD) for low-voltage power, control, and communication equipment.

1. Transient Voltage Surge Suppression (TVSS) nomenclature has been superseded in industry and standards organizations by term Surge Protective Device (SPD). Therefore, throughout this specification, terminology will be displayed as SPD.

B. Provide SPD at each building service entrance switchgear, switchboard and at other panelboard locations as indicated on Drawings.

C. Related Sections include the following:

1. Section 260508 "Common Work Results for Electrical, Communications and Electronic Safety" for facility voltages.
1. Section 260518 "Low-Voltage Electrical Power Conductors and Cables."
2. Section 260525 "Grounding and Bonding for Electrical Systems."
3. Division 26 Section on raceways and boxes.
1. Section 260815 "Field Testing and Inspection of Electrical Systems."

1.2 REFERENCES

A. ANSI C84.1, "Electric Power Systems and Equipment – Voltage Ranges."

B. IEEE C62.41.1, "IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits."

C. IEEE C62.41.2, "IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V or less) AC Power Circuits."

D. IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage Power Circuits."

E. IEEE Standard 1100 (Section 8.6.1), "IEEE Recommended Practice for Powering and Grounding Electronic Equipment."

F. UL 1283, "Electronic Interference Filters."

G. UL 1449, "Standard for Surge Protective Devices."

1.3 DEFINITIONS AND ACRONYMS

A. LED: Light Emitting Diode

B. TVSS: Transient Voltage Surge Suppressor

C. SPD: Surge Protective Device

D. VPR: Voltage Protection Ratings (UL 1449)

E. LTV: Let-Through Voltage

F. L-L: Line to Line

G. MCOV: Maximum Continuous Operating Voltage

H. In: Nominal Discharge Current. Peak value of current, selected by manufacturer, through SPD having current waveshape of 8/20 where SPD remains functional after 15 surges (UL 1449).

I. NRTL: Nationally Recognized Test Laboratory

J. Modes of Protection: Electrical paths where SPD offers defense against transient overvoltages (i.e., each line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G)).

K. Type 2 SPD: Permanently connected SPDs intended for installation on load side of service equipment overcurrent device, including SPDs located at the branch panel (UL 1449).

1.4 SUBMITTALS

A. Product Data: List of SPD Models/Part Numbers submitted, including dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, finishes, and mounting arrangements.

B. Design Data: Report documenting line-by-line compliance with requirements of this Section.

C. NRTL file numbers that demonstrate listings/certification to UL 1449.

D. Certified test data documenting IEEE C62.41.2 performance, and ability of device to meet all requirements of this specification.

E. Laboratory test data, including actual test graphs, showing that maximum let through voltage does not exceed values shown in Table 2.2 on “SPD Ratings” in this Section. Submittals shall include test results as required in the Table.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 10 years of engineering experience in design and manufacture of permanently connected SPD devices.

B. Manufacturer shall operate facility that is Quality System Certified manufacturing facility as ISO 9001 Compliant.

C. Installer Qualifications: Experienced installer of surge protective devices.

D. SPD devices shall be listed/certified in accordance with UL 1449 and shall have the UL Mark.

E. Source Limitations:

1. All SPD devices at service entrance shall be provided by same manufacturer.
2. All SPD devices at distribution panels shall be provided by same manufacturer.
3. All SPD devices at branch-panels shall be provided by same SPD manufacturer.

1.6 WARRANTIES

A. Manufacturer shall provide unlimited free replacement of the entire SPD (not just modules, components or sub-assemblies) for all SPD which cease to properly function (becomes inoperable, including LED outage) as a direct result of any electrical anomaly during the warranty period.

1. Warranty Period: 5 years from Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AC Data Solutions
2. Advanced Protection Technologies
3. Control Concepts (IslaGuard Series) (Liebert Corporation)
4. Current Technology
5. Eaton Corporation
6. EFI Electronics Corporation (Square D)
7. Siemens
8. Surge Suppression Incorporated
9. Thor Systems

2.2 GENERAL REQUIREMENTS

A. For 3-phase, 4-wire, wye connected systems, both seven mode or ten mode devices are acceptable when conforming to all requirements of this Section. Ten mode with L-L protection is optional. If L-L directly connected suppression elements are provided, manufacturer shall provide L-L kA value in Table 2.2, "SPD Ratings."

B. SPD devices shall be designed for AC power systems with minimum of AC follow current after operation. These devices are listed/certified as stand-alone Type 2 SPDs that may be installed internal or external to electrical panel they are intended to protect. In addition, whether installed or external to panel, connect SPDs to a dedicated multi-pole circuit breaker. SPDs shall be of non-modular design.

C. Service ratings: Maximum continuous operating voltage shall be capable of sustaining 115 percent of RMS Site Utilization Voltage continuously without degrading.

D. SPD Ratings: SPD devices shall not exceed ratings listed in Table 264315 - 2.2 according to location category in which SPD is to be installed.

TABLE 2.2

SPD RATINGS

	SERVICE ENTRANCE >800 AMP	DIST. PANELS ≤800 AMP & >225 AMP	BRANCH PANELS ≤225 AMP
Peak Surge Current (kA Per Phase) Defined as: 7 mode: Sum of L-N plus L-G 10 mode: Sum of L-N plus L-G plus L-L	240kA (200kA Residential)	160kA (150kA Residential)	120kA (80kA Residential)
UL 1449 I nominal	20kA	10kA	10kA
UL 1449 SCCR	100kA	100kA	100kA
UL 1449 VPR L-N (230/400V)	1200V	1200V	1200V
UL 1449 VPR L-G (230/400V)	1200V	1200V	1200V
UL 1449 VPR N-G (230/400V)	1200V	1200V	1200V
UL 1449 VPR L-L (230/400V)	2500V	2500V	2500V

E. Modes:

1. SPD system shall provide protection circuitry for all modes found in electrical distribution system at point of SPD application. (e.g., 400/230V, 3-phase Wye, 4-wire plus ground system has ten distinct modes requiring protection). These modes are each line to neutral,

each line to ground, each line to line and neutral to ground. Protect minimum of seven of these modes using independent and dedicated suppression elements (i.e., L1-N, L2-N, L3-N, L1-G, L2-G, L3-G, N-G). The ten mode protection SPD shall employ independent and dedicated suppression elements to protect additional modes of L1-L2, L2-L3, L1-L3. For three phase Delta systems, there are six modes requiring protection. These modes are each line-to-line and each line-to-ground. Provide minimum of three dedicated, independent, distinct protection modes (L1-G, L2-G, L3-G).

F. Fusing:

1. SPD shall provide, as minimum, over-temperature protection in form of component-level thermal fusing to ensure safe failure and prevent thermal runaway. Surge protective devices shall contain short circuit current safety protection within each device, for over-current requirements of the OBO Electrical Code.
2. Fusing mechanisms employed shall effectively coordinate their performance in conjunction with Limited Current, Intermediate Current and Sort Circuit Current testing under UL 1449.
3. SPD shall be listed/certified at or above available fault current level at point of SPD application in accordance with UL 1449. SPD shall be marked with short circuit current rating. SPD short circuit rating shall be, as minimum, same rating as power distribution equipment to which it is connected.

G. Features:

1. Surge protective devices shall provide on-board visual status of their operational readiness by LED indicator lights. Indicator lights shall be visible from front of panelboard, switchboard, or switchgear without opening of enclosure or door.
2. Provide label, on either exterior of unit or on interior of unit enclosure door, that lists required safety agency listing information including but not limited to the following ratings:

   a. Short Circuit Current Rating.
   b. VPR Ratings.
   c. MCOV Ratings.
   d. In Ratings.
   e. Type 2 SPD.

H. Maintenance Restrictions:

1. Do not provide SPD suppression units which require scheduled preventive- maintenance or replaceable modules. Units requiring functional testing, special test equipment, or special training to monitor surge protective device (SPD) status are not permitted. SPD devices shall require no routine maintenance.

I. Enclosures:

1. Unless otherwise noted, SPD enclosure type shall match or exceed NEMA enclosure rating of equipment to which it is connected. Minimum NEMA 1 for indoor installations and NEMA 3R for exterior locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install surge suppressor to be installed at each building service entrance gear, at other locations (service entrance) where service encounters as it enters facility, and as otherwise indicated on Drawings. Install SPD devices at all distribution, branch and panelboard locations as indicated on Drawings. Conductor lead length shall not exceed 500 mm.

B. Surge protection devices shall be Type 2. Connect surge protection devices on load side of over-current protective device to which they are connected, in accordance with UL 1449. To comply with UL 96 Lightning Protection Master Label, Type 2 SPD for service entrance equipment are required to be rated minimum 20 kA nominal discharge current, irrespective of amperage categories listed in Table for "SPD Ratings" above.

C. Multi-Section Panelboards: In instances where there are multi-section panels located in a facility, panelboards shall conform to the following:

1. Two section panels shall receive one SPD device located in Section 1 of two section panel.
2. Three section panels shall receive two SPD devices, one in Section 1 and one in Section 3. This is only acceptable if panels are immediately adjacent from each other and are sub-fed from previous section.
3. Any panels 1, 2, or 3 sections that have direct feeders tapped before panels, or do not meet criteria above, shall have their own SPD device.

D. SPD marked L1, L2, L3, N, and GND, as applicable, shall be connected respectively to phases, neutral, and ground.

E. For mandatory disconnect purposes, connect SPD device via dedicated branch multi-pole, circuit breaker rated in accordance with requirements of the OBO Electrical Code for protection of conductors, unless noted otherwise. Use of bus-bar connected SPDs is prohibited. Accomplish device over-current protection in accordance with internal fusing requirements indicated above.

F. Location of SPD, whether internal or external to panelboard shall be chosen to minimize lead lengths between SPD and circuit breaker including neutral and ground to which it is connected. Route SPD device leads which are mounted external to panel within metal conduit when necessary (rigid nipple if possible), and keep as short and straight as possible and as close as possible to neutral bar, ground bar and circuit breaker lugs. Install the SPD on the load side of the main breaker to the first breaker(s) after the incoming main breaker. Wire size for leads shall be as specified by manufacturer, minimum size 6mm^2 (#10 AWG), maximum size 35mm^2 (#2 AWG). Wire length shall not exceed 500 mm unless approved in writing by Project Director/COR based on input from OBO/PDCS/DE electrical engineer.

G. Mount surge protective devices as follows:

1. Mount permanently-connected devices parallel to service, distribution, and sub panels.
2. Mount series-connected devices as required for individual equipment protection, and as indicated on Drawings.
3. Panelboards: SPD shall not be mounted above or below panelboards. Mounting shall be either integral to panelboard assemblies or mounted to side with minimal conductor length.

H. Visibility: Indication lighting (LED) shall be visible from front of panelboard, switchboard, or switchgear without opening of enclosure or door.

I. Install surge protective devices neatly. Bind phase, neutral, and ground conductors tightly over entire run, from suppressor to service panel, and use shortest length of connecting cable possible. Twisting (braiding) of conductor cables is required to reduce wire impedance.

J. Connect surge protector to grounding system.

K. Electrical installer shall verify proper application of SPD (e.g., voltage, phases). Electrical installers shall assure that all Neutral conductors are bonded to system ground at service entrance or serving isolation transformer prior to installation of associated SPD. Electrical installer shall ensure that neutral-to-ground bonds do not exist at locations that are not service entrances or newly derived power sources.

L. All labor required for, and incidental to, installation of SPD system components performed by electrical installer.

M. To ensure proper operation of SPD, connect devices to system with breaker in “OFF” position. Do not energize until approval of neutral and ground bonding is received from Project Director/COR based on input from OBO/PDCS/DE electrical engineer. Devices are frequently damaged during construction, and replacement of damaged devices that were energized without approval is at Contractor’s expense.

3.2 FIELD QUALITY CONTROL

A. Refer to Section 260815 “Field Testing and Inspection of Electrical Systems.”

3.3 DEMONSTRATION

A. Contractor shall train Government maintenance personnel in use and maintenance of SPD. Training may be performed by electrical subcontractor; it is not required that manufacturer’s representative perform training.

END OF SECTION 264315

SECTION 265105 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Interior LED lighting fixtures and LED Drivers.
2. Lighting fixtures mounted on exterior building surfaces.
3. Emergency lighting units.
4. Exit signs.
5. Accessories.

B. Related Sections include the following:

1. **[Division 23 Section on "Air Diffusers" for air handling light fixtures.]**
2. Division 26 Section “Vibration and Seismic Controls for Electrical Systems.”
3. Section 262725 "Wiring Devices" for manual wall-box dimmers for LED lamps.
4. Section 260924 "Lighting Control Devices" for automatic stand-alone control of lighting, including photoelectric relays, in-wall occupancy sensor switches, and multipole lighting relays and contactors.
5. Section 260934 "Centralized Dimming Controls" for architectural dimming systems, including occupancy sensors, multiple lighting controllers, and lighting control system software.

1.2 DEFINITIONS

A. CRI: Color rendering index.

B. CCT: Correlated color temperature.

C. CU: Coefficient of utilization.

D. DALI: Digital Addressable Lighting Interface

E. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:

1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

F. LED: Light Emitting Diode

G. Lumen: Measured output of lamp and luminaire, or both.

H. Luminaire: Complete lighting unit, including lamp, reflector, and housing

I. RCR: Room cavity ratio.

J. RoHS: Restriction of Hazardous Substances Directive

K. CWA: Constant Wattage Autotransformer

1.3 PROHIBITED FIXTURE TYPES

A. The following fixture types are prohibited:

1. Incandescent fixtures.
2. Fluorescent fixtures.
3. High Intensity Discharge (HID) fixtures.

1.4 TECHNOLOGY RESTRICTIONS

A. In accordance with Chapter 1 of the OBO Electrical Code, LED drivers using Near Field Communication (NFC) for configuration is prohibited.

1.5 SUBMITTALS

A. Product Data: For each type of lighting fixtures, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Arranged in order of luminaire designation
2. Material and physical (configuration) description of lighting fixture including dimensions.
3. Include data on features, accessories, and finishes.
4. Emergency lighting units including battery and charger.
5. Energy-efficiency data.

6. [Air-Handling Lighting Fixtures:

a. Air and Thermal Performance Data: Furnish data required in Article on SUBMITTALS in Division 23 Section on "Air Diffusers."
b. Sound Performance Data: Indicate sound power level and sound transmission class in test reports certified according to standards in Article on SUBMITTALS in Division 23 Section on "Air Diffusers."]

7. General Data: Life expectancy, output (lumens, CCT, and CRI), and Color Temperature (Kelvin).
8. Photometric data, in IESNA format, based on certified results of laboratory tests of each lighting fixture type, outfitted with light bars, drivers, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer in accordance with IES LM-79 and LM-80 for solid state lighting.

9. Low Voltage Transformers.
10. LED power supplies.

B. Shop Drawings:

1. Show details of nonstandard or custom lighting fixture.
2. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
3. Mounting details and seismic bracing
4. For modified luminaries or linear luminaries mounted in continuous rows, submit scaled drawings prepared by the manufacturer showing details if construction, lengths in runs, pendant or power feed locations, accessories, finishes, and lists of materials.
5. Include wiring Diagrams: Power and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached **[including seismic strengthening]**.
4. Other items in finished ceiling including the following:

a. Air outlets and inlets.
b. Speakers.
c. Sprinklers.
d. Smoke and fire detectors.
e. Occupancy sensors.
f. Photosensors
g. Access panels.
h. **[Insert item.]**

5. Perimeter moldings.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture/Luminaire Schedule. Each sample shall include the following:

1. LED Driver.
2. Accessories: Cords and plugs.

E. Product Certificates: For each type of LED driver, signed letter on company letterhead stating that NFC is not used or has been permanently disabled by product manufacturer.

F. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Qualification Data: For agencies providing photometric data for lighting fixture.

H. Field quality-control test reports.

I. Warranties: Submit two copies of each warranty conforming to warranty requirements of this Section.

J. Operation and Maintenance Data: For lighting equipment, controls and fixtures, including emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA, and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

B. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

C. [FMG Compliance: Fixtures and electrical devices for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.]

D. Mockups: Provide lighting fixtures and mounting mockups, with one mockup for each combination of fixture and mounting. Install fixtures for mockups with power and control connections.

1. Obtain Project Director/COR’s approval of fixture for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Recessed lighting fixtures shall have frames that are compatible with ceiling system indicated on Architectural drawings.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. LED Fixtures: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lens: One per every 100 of each type and rating installed. Furnish at least one of each type.
3. Batteries: Five for every 100 of each type installed.
4. Chargers: One for every 100 of each type installed.
5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.9 WARRANTY

A. Warranty for Fixtures and Drivers:

1. Manufacturer’s standard form in which manufacturer agrees to repair or replace fixtures or components that fail in materials or workmanship within specified warranty period.
2. Failure includes:

   a. Substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
   b. Operational failure of LED drivers.
   c. Defective or non-starting of more than 10 percent of LED sources in individual lightbar or subassembly(s); lightbar or subassembly(s) shall be replaced.

3. Warranty Period: 10 years from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries. Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 FIXTURES AND COMPONENTS, GENERAL

A. Furnish fixtures of type, kind, and with the type of LED driver as indicated in Lighting Fixture/Luminaire Schedule, on Drawings, and as specified herein.

B. Lighting fixtures shall be free of light leaks, warps, dents, or other irregularities. Lenses shall be free of cracks, chips, or discolorations.

C. Metal surfaces of lighting fixtures shall be bonderized, galvanized, or sheradized after fabrication and treated to provide rust inhibiting and finish coat adherence properties.

D. Fixtures installed where exposed to weather and/or cold temperatures shall be weatherproof and suitable for efficient operation at temperatures and conditions encountered.

E. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

F. LED Fixtures:

1. Comply with UL 1598. Color temperature shall match all interior spaces (plus or minus 200K).
2. LED Cove Light Fixtures: Fixtures shall be designed to house LEDs and optical assembly as well as to provide required thermal management properties for highest wattage solution available. Junction temperature shall not exceed 80 degrees C. These light fixtures shall be pre-wired and pre-assembled. Electronic drivers (power supplies) shall be integral within sheet metal wireway housing. Power consumption for standard LED is 12 watts/ft maximum, and for high output LED is 17.8 watts/ft maximum.
3. Tunable White LED fixtures: Use DALI Addressable LED drivers to control CCT and intensity separately. CCT should be between 2700K to 5000K at a minimum.

G. Metal Parts: Free of burrs, sharp corners, and edges. Intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly.

H. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging. Fixtures to be painted after fabrication.

I. Doors, Frames, and Other Internal Access: Smooth operating, and free of light leakage under operating conditions. Design to permit relamping without use of tools. Design to prevent doors, frames, lenses, diffusers, and other components from falling accidentally either during relamping and or when secured in operating position. Safety devices shall be detachable if necessary and shall not interfere with fixture performance, maintenance or the seating of any lighting element, nor shall it be visible during normal fixture operation and from normal viewing angles.

J. Lighting fixtures provided shall have means for disconnection from power source during service, as required in NEC Article 410.

K. Lighting fixture drivers shall meet NEMA 410 (current revision) requirements for the Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.

L. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

M. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 3.2 mm minimum unless different thickness is scheduled.
   b. Lenses shall have uniform brightness throughout the entire visible area without LED pixilation.
   c. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

N. Damp or Wet listing as applicable

O. [Air-Handling LED Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section on "Air Diffusers."

1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat Removal Units: Air path leads through lamp cavity.
3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of fixture door with air supply same as for air supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.]

2.2 LED LIGHTING FIXTURES AND DRIVERS

A. All LED lighting fixtures:

1. Comply with IES LM-79-08, Approved method for measuring lumen maintenance of LED light sources.
2. Comply with IES LM-80-08, Approved method for electrical and photometric measurement of SSL product.
3. Fixtures shall comply with RoHS restrictions.

4. LED arrays shall be sealed, high performance, long life type; minimum 70 percent rated output at 50,000 hours in accordance with IES L70.
5. Fixtures shall deliver minimum of 80 lumens per watt.

    a. LEDs shall be “Bin No. 1” quality.

6. Fixtures shall have internal thermal protection.
7. Fixtures shall not draw power in off state. Fixtures that are individually addressable with external control and intelligence (DALI) are exempt from this requirement; however, power draw for these cannot exceed 0.5 watts when in off state.
8. Indoor fixtures shall have minimum CRI of 85.
9. Fixtures shall be fully accessible from below ceiling plane for changing drivers, power supplies and arrays.

B. Power Supplies and Drivers

1. Designed for 10 year operational life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
2. Comply with RoHS restrictions.
3. Power Factor: 0.90 or higher
4. Maximum driver case temperature shall not exceed driver manufacturer recommended in-situ operation.
5. These components shall be designed and tested to withstand electrostatic discharges without impairment; testing shall be in accordance with IEC 61000-4.2.
6. UL 8750 recognized or listed as applicable.
7. Surge Tolerance: Designed and tested to withstand surges of 4,000V in accordance with to IEEE C41.2 without impairment of performance.
8. Class A sound rating; inaudible in a 27 dBA ambient.
9. Interference: EMI and RFI shall conform to FCC 47 CFR Part 15.
10. Total Harmonic Distortion Rating: Less than 20 percent; comply with ANSI C82.11.
11. Conform to electrical and thermal conditions as described in IES LM-80 Section 5.0.
12. Fully Dimmable: Refer to Fixture Schedule on Drawings for required dimming range.
13. No visible change in light output shall be evident with variation of plus or minus 10 percent line voltage input.
14. Drivers shall track evenly across multiple lamp lengths and all light levels.
15. Refer to Article on TECHNOLOGY RESTRICTIONS regarding prohibition of NFC for driver configuration.

2.3 LED ARRAYS

A. All LEDs of same type shall be provided by same manufacturer.

B. Equip each lighting fixture with proper LED array of type indicated or specified in Fixture Schedule.

2.4 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, conform to Codes of OBO.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type, two hour capacity sealed.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Power Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

1) Remote Test Capability: To facilitate Code required testing of exit signs, provide switch in hand-held remote device which can be aimed in direction of tested unit to initiate coded infrared signal. Factory install infrared receiver inside fixture. Signal reception by infrared receiver in tested unit shall trigger simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response. Basis of Design: Bodine RCT series.

f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

3. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Lamping: LED
4. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

7. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Vibration and Seismic Control for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 13-mm (0.5 inch) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 13-mm (0.5 inch) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires:

1. ASTM A 641/A 641M "Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire, Class 3, soft temper, zinc-coated steel**,** 2.7 mm (12 gage).
2. BS EN 10244-2:2001 "Steel Wire & Wire Products- Non-Ferrous Metallic Coatings on Steel Wire – Part 2 Zinc or Zinc Alloy."
3. ISO 7989:1988 "Zinc Coatings for Steel Wire."

E. [Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 2.7 mm (12 gage).]

F. Rod Hangers: 5-mm (3/16 inch) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrate assembly matched to fixture and line voltage, and equip with threaded attachment, cord, and locking-type plug.

H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Completely connect and securely mount lighting fixtures. Provide supports and hangers as necessary to securely fasten and support lighting fixtures.

   a. Confirm weight and mounting method of all lighting fixtures prior to ordering fixtures and ensure suitable support. Coordinate with General Contractor for lighting fixtures that require additional blocking support.
   b. Where conflicts are identified in the field, refer to coordination drawings (see Article on SUBMITTALS) and architectural reflected ceiling plans for coordination of lighting fixture locations with mechanical, fire protection, lighting controls, and fire safety equipment. Coordinate through General Contractor with Architect, Engineer, and Lighting Designer, and submit proposed resolutions to Project Director/COR prior to installing any of the Systems.

2. Install lighting fixtures plumb and true, and square with ceilings and walls, and secure in accordance with manufacturer's written instructions and approved submittal materials, unless otherwise indicated. Install continuous rows of fixtures such that rows appear as continuous system without visible vertical or horizontal undulation.
3. Hang pendant fixtures plumb, and with no "kinks" in pendants or cable.
4. Verify the types needed for various ceiling conditions. Provide plaster rings where necessary for installation.
5. Piercing of metal decking for lighting fixture support is not permitted.
6. Securing fixtures to ductwork or other systems is not permitted.
7. Wire in accordance with requirements of branch circuit installation. Properly ground each lighting fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. Install minimum of four ceiling support system rods or wires for each lighting fixture. Locate supports not more than 150 mm from fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each lighting fixture corner with clips that are UL listed for the application.
3. Lighting Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans, or otherwise center in acoustical panel, and support fixtures independently with at least two 20-mm metal channels spanning and secured to ceiling tees. In addition, provide slack earthquake safety wire hangars secured diagonally from opposite fixture corners to structural members, or structural slab, above suspended ceiling.

4. [Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of lighting fixture at safety factor of 3.]

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 1200 mm, brace to limit swinging.
2. Stem-Mounted, Single-Unit Lighting Fixture: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of lighting fixture chassis, including one at each end.
4. Do not use grid as support for pendants. Connect support wires or rods to building structures.
5. All power feeds shall originate from the same location/end of each run.
6. Where pendants or rods are longer than 122cm (42in), brace to limit fixture swinging.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

3.2 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after installation. Ensure dimming is from 100 percent to minimum lighting intensity as defined on the Fixture Schedule. Dimming shall be continuous and flicker-free.

C. Replace all inoperable LED arrays at the end of construction prior to OBO beneficial occupancy.

D. Malfunctioning Lighting Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

E. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

F. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.3 CLEANING AND ADJUSTING

A. Remove protective plastic covers from lighting fixtures and fixture diffusers only after construction work, painting, and clean-up are completed. Remove, clean, and reinstall all dirty reflectors and diffusers.

B. Adjust aimable lighting fixtures to provide required light intensities. Securely lock aimable lighting fixtures in place after acceptable aiming.

C. Clean lighting fixtures internally and externally after installation. Remove construction dirt, dust, paints, and otherwise leave fixtures and lamps in clean and ready condition upon project closeout. Use methods and materials recommended by manufacturer for cleaning Alzak reflectors and other surfaces.

D. Lighting fixtures, reflectors, louvers, and accessories which are damaged, blemished, or impregnated with fingerprints shall be replaced at this Contractor's expense. All finishes shall be unmarred upon Project completion.

END OF SECTION 265105

SECTION 265554 – UNDERCARRIAGE VEHICLE INSPECTION LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Resin-encased linear light emitting diode (LED) lighting system, installed as in-ground uplighting within vehicle traffic lane, to assist with undercarriage inspection.

1.2 SUBMITTALS

A. Product Data: For lighting system specified in this Section, including associated components and accessories. Include data on features, accessories, finishes, and the following:

B. Shop Drawings: Submittals shall contain sufficient installation and schematics to clearly describe system apparatus and installation procedures. Clearly identify all conduit runs, LED lengths, and power supply locations based on Construction Documents.

1. Wiring Diagrams: Power and control wiring.
2. Load Profile: Instantaneous and continuous loads at high/low output.
3. Lumen output: Identified light output at measured distances.

C. Installation Manuals: For lighting and associated power supply.

D. Operation and Maintenance Data: For lighting system and associated power supply. Include emergency, operation, and maintenance procedures.

E. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by testing agency acceptable to Project Director/COR and marked for intended use.

B. Engage a company that specializes in manufacturing of lighting system identified in this Section with a minimum of three years' experience.

C. Installer: Minimum of five years installation experience of similar equipment such as up-lights in vehicle traffic areas.

D. Comply with IEEE C2, "National Electrical Safety Code."

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store lighting system components in manner to prevent distortion, damage or discoloration to lighting strips.

B. Retain factory-applied wrappings on LED components until immediately before installation.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting system, including power supply, that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather or solar radiation within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
2. Warranty excludes lamps, ballast, and fuses. Warranty excludes lightning damage, hail damage, solar flares, acts of war, vandalism, abuse, and unauthorized repairs or alterations.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Permanently installed in-ground uplighting system using resin-encased linear light emitting diodes (LED).

B. Illumination: Provide 120 deg. Output patter with uniform light devoid of obscuring shadows and capable of delivering minimum 654 lux (60 foot candles) at 300 mm (12 inches) above road surface. Length of lighting section shall approximately match length of sally port. Provide two settings of light levels, with one higher than the minimum levels identified above.

C. Color Temperature: 6000-7000 deg. K.

D. Environmental Resistance: Utilize flexible resin material to provide U.V. and oxidation resistance, natural hydrophobic and weather resistance, while keeping present water clear to prevent loss of illumination.

1. Encasement: Encase ground level lighting system components with cast flexible resin.

E. Low Voltage Wiring: Provide minimum 15 meters (50 ft) length from lighting to power supply, including portions embedded within resin casing. Include redundancy in wiring to prevent outages.

2.2 BASIS OF DESIGN

A. Resin-Encased Linear Light Emitting Diodes (LED): Delta Scientific UVLS100.

2.3 LED SYSTEM

A. Provide system conforming to requirements identified in Article on SYSTEM DESCRIPTION.

2.4 POWER SUPPLY

A. Power supply shall be sized to provide power for light output requirements identified in Article on SYSTEM DESCRIPTION.

B. Enclosure: Rigidly formed enclosure that will not warp, sage, or deform in use. NEMA Type 4 enclosure.

C. Power System: Universal power supply, 100-240 VAC, 50/60 Hz input at 2 amps, **[277 VAC at 0.68 amps.]**

2.5 ACCESSORIES

A. Installation Accessories:

1. Sealant: Lighting manufacturer recommended outdoor-rated, self-leveling sealant.

B. Inspection Accessories:

1. Two trapezoidal-shaped under-vehicle search mirrors with replaceable mirror face.
2. One linear over-vehicle extension search mirror with LED strip illumination.
3. One fiber-optic hand-held inspection wand with 360 degree illumination capability.

2.6 FACTORY QUALITY CONTROL

A. LEDs and power supply shall pass full functionality inspection by lighting manufacturer prior to shipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check critical dimensions for accuracy against accepted shop drawings.

3.2 PREPARATION

A. Site Preparation: Saw cut area or block out area in concrete construction for lighting system prior to installation of lighting system components.

3.3 INSTALLATION

A. General Installation: Comply with manufacturer's installation instructions.

B. Install two LED lighting strips and one power supply as indicated in Drawings and conforming to requirements in Article on SYSTEM DESCRIPTION. Center lighting system in sallyport. Provide 800 millimeter (31.5 inch) center-to-center spacing between two lighting strips.

C. Place underground and above-grade conduits prior to installation of lighting system components. Seal conduit to prevent entrance of water, and to prevent passage of air and thus prevent condensation.

3.4 FIELD QUALITY CONTROL

A. Inspection: Prior to field testing, Contractor shall inspect the following, and perform field adjustments accordingly consistent with requirements of this Section:

1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
2. Inspect LEDs for light output, and evenness of light throughout its length.
3. Inspect quality of resin pour encasement.
4. Inspect Operations: Verify high/low operation of lighting units after installing encased LEDs and energizing circuits with normal power source. Verify operation of photoelectric controls.

B. Field Testing: Upon completion of construction, Contractor shall field test each traffic lane lighting system. Test shall include electrically turning system on/off and testing two levels of lighting. Contractor shall furnish all test equipment, make necessary corrections and adjustments prior to test witnessed by Project Director/COR.

1. Include measurement of light intensities at night. Use lux/foot candle meter or equivalent with calibration referenced to NIST standards. Light system must provide minimum of 645 lux (60 foot candles) of evenly distributed light at 300 mm (12 inches) above vehicle undercarriage.
2. Any conditions that interfere with proper operation of lighting system disclosed by test shall be corrected at no additional cost to the Government. After adjustments are made to assure correct functioning of components, applicable tests shall be completed, including repeating previous tests where test results require adjustments.

3.5 DEMONSTRATION

A. General: Factory-authorized representative shall train Government maintenance personnel to adjust, operate, and maintain lighting system devices and associated power supply.

END OF SECTION 265554

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts but not mounted on exterior surfaces of buildings.
2. Luminaire-mounted photoelectric switches.

B. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete.”
2. Section 265105 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.
3. Section 265554 “Undercarriage Vehicle Inspection Lighting” for separate exterior lighting system.
4. Section 282305 “Security Video System (SVS).”

1.2 DEFINITIONS

A. CRI: Color rendering index.

B. HID: High-intensity discharge.

C. LED: Light-Emitting Diode.

D. Luminaire: Complete lighting fixture, including ballast housing if provided.

E. Pole: Luminaire support structure, including tower used for large area illumination.

F. Standard: Same definition as "Pole" above.

1.3 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.

5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

    a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. TM-21 report data.
7. Photoelectric relays.
8. Ballasts, including energy-efficiency data.
9. Lamps, including life, output, and energy-efficiency data.
10. Materials, dimensions, and finishes of poles.
11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
12. Anchor bolts for poles.
13. Manufactured pole foundations.

B. **[Manufacturer's standard color chart for aluminum finishes.]**

C. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
3. Wiring Diagrams: Power and control wiring.
4. **[Seismic restraints.]**

D. Factory Test Data:

1. Manufacturer shall submit proof of IK10 rating for housing assembly.
2. Manufacturer shall submit proof of IK10 rating or greater for optics against mechanical impact (excluding decorative post top fixtures)

E. **[Seismic Design: Qualification data, design data, and calculations.]**

F. Soil tests reports for lighting poles.

G. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire has been included in design.

H. Field quality-control test reports.

1. Photometric test reports to demonstrate conformance with Appendix B of the Zoning Code of Overseas Buildings Operations. Submit separate report for LED lamps.

I. Operation and Maintenance Data: For luminaires poles to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

B. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Manufacturer Qualifications: Luminaire manufacturer needs to demonstrate in excess of 30 years of experience in manufacturing outdoor luminaires and 10 years of experience in manufacturing LED luminaires and controls.

1.5 DELIVERY, STORAGE, AND HANDLING

A. **[Package aluminum poles for shipping according to ASTM B 660.]**

B. Store poles on decay-resistant-treated skids at least 300 mm (12 inches) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamp Fixture: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
5. Batteries: Five for every 100 of each type installed.
6. Chargers: One for every 100 of each type installed

PART 2 - PRODUCTS

2.1 PERFORMANCE STANDARDS OF SITE LIGHTING

A. Site lighting shall conform to requirements in Chapter 8 of the Zoning Code of Overseas Buildings Operations.

B. Corrosion Resistance for Lighting Poles:

1. Low or Moderate Atmospheric Corrosivity: Steel or aluminum poles.
2. Extreme Atmospheric Corrosivity: Prestressed concrete poles
3. Wood poles are not permitted.

2.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 2200 N (500 lbf), distributed in accordance with AASHTO LTS-4-M.

C. **[Ice Load: Load of 0.15 kN/m^2 (3 lbf/sq. ft.), applied in accordance with AASHTO LTS-4.]**

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4 and as determined by analysis of local conditions.

1. Wind speed for calculating wind load for poles exceeding 15 m in height is **[50 m/s (110 mph)]**.
2. Wind speed for calculating wind load for poles 15 m in height or less is **[50m/s (110 mph)]**.

E. **[Seismic Resistance: Poles installed in areas requiring seismic bracing shall have bracing designed in accordance with the Building Code of Overseas Buildings Operations. Seismic restraints shall be designed by a professional engineer.**

1. **Seismic Influences: Increase the strength of mounting or supporting components or add seismic restraints, or both, to improve resistance to failure due to flexure, separation of poles from foundations, or separation of lighting fixtures from mountings.]**

2.3 PERFORMANCE REQUIREMENTS OF LIGHTING POLES

A. Delegated Design: Engage a qualified professional engineer, to design pole foundation and pole power system.

B. **[Seismic Performance: Foundation and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.]**

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: **[1.0]**.

3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. Structural Characteristics: Comply with AASHTO LTS-6-M.

D. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

E. **[Ice Load: Load of 145 Pa (3 lbf/sq. ft.), applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.]**

F. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles exceeding 15 m (50 feet) in height is **[45 m/s (100 mph)][40 m/s (90 mph)] Insert value from AASHTO LTS-6-M for this Project>.**

   a. Wind Importance Factor: [**1.0**] <**Insert value from AASHTO LTS-6-M**>.
   b. Minimum Design Life: 50 years.
   c. Velocity Conversion Factor: [**1.0**] <**Insert value from AASHTO LTS-6-M**>.

2. Basic wind speed for calculating wind load for poles 15 m (50 feet) high or less is [**45 m/s (100 mph)**] [**40 m/s (90 mph)**] <**Insert value from AASHTO LTS-6-M for this Project**>.

   a. Wind Importance Factor: [**1.0**].
   b. Minimum Design Life: 50 years.
   c. Velocity Conversion Factor: [**1.0**] <**Insert value from AASHTO LTS-6-M**>.

G. Strength Analysis: For each pole, multiply the actual Effective Projected Area (EPA) of luminaires and brackets by a factor of [**1.1**] <**Insert number**> to obtain the EPA to be used in pole selection strength analysis.

H. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.4 NON-LED LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IES RP-8 18 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Design to prevent doors, frames, lenses, diffusers, and other components from falling accidentally either during maintenance or when secured in operating position. Design to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel 316 SS minimum.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color to match poles.

M. **[Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.**

1. **Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.**
2. **[Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker), complying with AAMA 611.]**
3. **[Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.]**

    a. **Color to match poles.]**

2.5 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 30 deg C and higher.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
3. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
4. Transient-Voltage Protection: Comply with IEEE C62.41 and IEEE C62.41.2 Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 30 deg C and higher.

D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

E. Compact Fluorescent Lamps: CRI 80 (minimum), color temperature 3500 K, averaged rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.

1. T4, Double-Twin Tube: Rated 18 W, 1200 initial lumens (minimum).
2. T4, Double-Twin Tube: Rated 26 W, 1800 initial lumens (minimum).

2.6 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated:

1. Type: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 30 deg C for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 50 deg C.

4. Open-circuit operation will not reduce average life.
5. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.

C. High-Pressure-Sodium Ballasts: Solid-state igniter/starter with an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant Restrike Device: Solid-state potted module, mounted inside high-pressure-sodium fixture and compatible with high-pressure-sodium lamps, ballasts, and sockets up to 150 W.

a. Restrike Range: 200 to 260 V ac.
b. Maximum Voltage: 440 V peak or 260 V ac RMS.

2. Single-Lamp Ballasts: Minimum starting temperature of minus 50 deg C.
3. Open-circuit operation will not reduce average life.

2.7 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.

1. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.

B. Metal-Halide Lamps: ANSI C78.43, with a minimum CRI 65, and color temperature 4000 K.

1. Metal halide lamps shall be ceramic and shall be Type T, self-extinguishing within 15 minutes when the outer envelope of the lamp breaks. **[If the wattage needed is not available in a type T, use a lamp other than metal halide.]**
2. Metal halide lamps shall be color matched.
3. Metal halide sources shall only be operated in lighting fixtures designed for that use and in specified position.
4. To minimize lamp breakage, protect envelope from direct contact with water during operation.
5. Provide phosphor-coated lamps in wattages and envelope sizes unless otherwise indicated on Drawings in Lighting Fixture/Luminaire Schedule for non-PAR Metal Halides.

2.8 LED LUMINAIRES

A. General:

1. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
2. Each Luminaire shall consist of assembly that utilizes LEDs as light source. In addition, complete luminaire shall consist of housing, LED array, and electronic driver (power supply).
3. Reported lumen maintenance (using U.S. Dept. of Energy (DOE) Energy Star TM-21 Calculator) shall be greater than 95 percent per TM-21-11 after 78,000 hours of luminaire operation in an ambient environment of 40 deg C (104 deg F). This data must be TM-21 compliant and derived from the EnergyStar.gov TM-21 Calculator.
4. Fabricate luminaire such that LED modules may be replaced or repaired without replacement of luminaire.
5. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or approved equivalent standard from nationally recognized testing laboratory.

    a. Luminaire shall be DLC approved.
    b. Country of manufacture shall be TAA compliant

B. Electrical Requirements:

1. Operation Voltage: Fluctuations of line voltage shall have no visible effect on luminous output. Luminaire shall operate at 50/60 HZ ±3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC.
2. Power Factor: The luminaire shall have power factor of 0.9 or greater.
3. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
4. Surge Suppression: Luminaire circuitry shall include surge protection devices (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. SPD shall be field-replaceable. SPD shall operate as below:

    a. SPD protects luminaire from damage and failure for common and differential mode transient peak currents up to 10 kA (minimum). SPD shall conform to UL 1449 and have been tested using procedures in ANSI/IEEE C62.41-2:2002 category C high exposure and ANSI C136.2 10kV BIL to enhanced test level SPD shall fail in such a way that luminaire will no longer operate.

5. RF Interference testing shall conform to Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B or C, Section 15 regulations concerning emission of electronic noise for entire luminaire construction.
6. Driver shall have load regulation: +/- 1 percent from no load to full load.
7. Driver shall output Ripple of less than 10 percent.
8. Driver output shall be isolated.
9. Driver case temperature shall be rated for -40 deg C to 80 deg C.
10. Driver shall be fully encased and IP65 rated.
11. Driver shall include protection for: overheat, self-limited short circuit, and overload.
12. Luminaire shall provide a 0-10V dimming driver with minimum 10 percent dimming.
13. Luminaire shall include all the following as options: NEMA 3-PIN, NEMA 7-PIN, and Zhaga 4-PIN receptacle.

14. Luminaire shall have configuration which offers capability to incorporate an integrated security camera and all associated network hardware capable of communicating using ethernet/fiber optic.

C. Electrical Safety: Wet listed and listed for operation in high ambient temperatures in either U.S., Canada, ENEC, CE, ROHS, or EMI.

D. Driver:

1. Load Regulation: +/- 1 percent from no load to full load.
2. Output Ripple: Less than 10 percent.
3. Output shall be isolated.
4. Case Temperature: Rated for -40 deg C through +80 deg C.
5. Power Supply Enclosure: Fully encased and potted, IP65.
6. Protection: Overheat, self-limited short circuit, and overload.

E. Optical Requirements:

1. Optical Assemblies: LEDs shall be provided with discrete over optical elements to provide IES Type II, III, IV or V distribution. Optical assemblies shall have minimum efficiency of 85 percent regardless of distribution type. All LEDs and optical assemblies shall be mounted parallel to ground. All LEDs shall provide same optical pattern such that failure of individual LEDs will not constitute loss in distribution pattern.
2. Luminaire manufacturer shall provide House Side Shield option to be field or factory installed. House Side Shield shall not affect luminaire EPA nor protrude from luminaire more than 25 mm (1/4 inch) below bottom plane of fixture.
3. Light Color/Quality: Luminaire shall have correlated color temperature (CCT) of 4,000 deg K +/-275 deg K. Color rendition index (CRI) shall be minimum 70.
4. Individual LEDs shall be constructed such that failure of one LED will not result in loss of entire LED module.
5. Optic assembly shall be protected against dust and moisture intrusion in accordance with IP-66 (minimum) to protect all internal components.
6. Optic assembly shall be protected against mechanical impact and be IK10 rated.
7. Each refractor or lens shall be made from UV inhibited high impact optical grade polycarbonate and be resistant to scratching.

F. Thermal Management:

1. Rated operating temperature range shall be -40 deg C (-40 deg F) to +40 deg C (104 deg F) with option of a +50 deg C (122 deg F) configuration.
2. Thermal management (of heat generated by LEDs) shall be sufficient capacity to assure proper operation of luminaire over expected useful life. Demonstrate using TM-21 Calculator that LED will not exceed max operating temperature with outdoor ambient at 50 deg C.
3. Electrical compartment temperatures shall not exceed 85 deg C in any configuration. These tests need to be performed assuming inclusion of all possible options and accessories in driver compartment with ambient at 50 deg C.

4. Thermal management shall be passive by design. Use of fans or other mechanical devices is not allowed.
5. When conducting testing required for TM-21 Calculator, demonstrate that case temperature for LED was taken at hottest point on surface.
6. TM-21 Calculator report data shall either represent exact configuration of fixture or a configuration of maximum LEDs at highest drive current.
7. Driver shall be thermally protected such that fixture will go into protective mode if operating temperatures exceed rated parameters. Fixture shall maintain full output at 50 deg C ambient condition.

G. Physical and Mechanical Requirements

1. Heavy-wall die-cast aluminum housing. Design housing to allow water runoff on top of housing when mounted horizontally.
2. Protect housing assembly against mechanical impact.
3. Protect optics against mechanical impact.
4. Housing shall conform to NEMA/UL wet location and shall be UL 1598 listed.
5. Protect luminaire against dust and moisture intrusion in accordance with IP-66 (minimum).
6. Assembly and manufacturing process for LED luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration. Luminaire shall withstand vibration, conforming to ANSI C136.31 American Standard for Roadway and Area Lighting Equipment – Luminaire Vibration for normal and bridge operation (3G minimum in all 3 planes tested in heaviest configurations, 1.5G for decorative post to fixtures).
7. Housing shall be aluminum and suitable for coastal condition. It shall be finished with a nominal 2.5 mil thick TGIC Polyester Powder Coat finish able to withstand a 5,000-hour salt spray test per ASTM B117, with a scribe rating of 9 at 2000 hours per ASTM D1654.
8. Luminaire to be packaged in a suitable carton that withstands ISTA-1A Drop testing requirements. Packaging: Vibration, Shock (Drop) and Compression testing (reference ISTA 1C procedure) luminaires and components to be packaged in a way to avoid breakage, bending and scoring finishes.

2.9 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in the Part 2 Article on STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION," with a gust factor of 1.3.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components. Hot-dip galvanized in accordance with ASTM A153, Class C.

1. Materials: Shall not cause galvanic action at contact points.
2. Mountings: Correctly position luminaire attachment to provide indicated light distribution.
3. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
4. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 65 by 130 mm (2-1/2 by 5 inches), with cover secured by stainless-steel captive screws.

E. Mast Arms: **[Single-arm] [Truss] [Davit]** type**[, continuously welded to pole attachment plate]**. Material and finish same as pole.

F. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

G. Breakaway Supports: Frangible breakaway supports for indicated poles, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-3.

H. Touch up finishes as required to inhibit corrosion where welding is involved.

2.10 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 320 MPa; 1-piece construction up to 12 m in height.

1. Shape: Round, tapered.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Metal Pole Brackets: Cantilever brackets without underbrace, with straight tubular end section to accommodate luminaire. Match pole finish.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with stainless -steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 380-mm (15-inch) vertical spacing, alternating on opposite sides of pole; first step at elevation 3 m (10 feet) above finished grade.

F. Grounding and Bonding Lugs: Welded 13-mm (1/2-inch) threaded lug, complying with requirements in Section 260525 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

I. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: Match Project Director/COR’s custom color.

2.11 ALUMINUM POLES

A. **[Poles: Seamless, extruded structural tube complying with ASTM B 429, 6063-T6 alloy.]**

B. **[Poles: ASTM B 209M, 5052-H34 marine sheet alloy.]**

1. Shape: Round, tapered.

C. Pole-Top Tenons: Fabricated to support fixtures or fixtures/brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 12 mm threaded lug, complying with requirements in Section 260525 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Fasteners: Stainless steel, size and type as determined by manufacturer based upon corrosion risk identified for the project. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

F. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate lighting fixture.
2. Finish: Same as pole.

G. **[Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.**

1. **Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.**
2. **[Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.]**
3. **[Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.]]**

H. **[Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.**

1. **Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.**
2. **Powder coat shall comply with AAMA 2604**

a. **Electrostatic applied powder coating; single application with a minimum 64- to 89-um (2.5- to 3.5-mils) dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.**
b. **Color: As selected by Architect from manufacturer's full range.**]

2.12 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Section 262725 "Wiring Devices" for ground-fault circuit-interrupter type.

1. Recessed, 300 mm (12 inches) above pole base.
2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, color to match pole**,** that when mounted results in NEMA 250, Type 3R enclosure.
3. With cord opening.
4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s) and other specified accessories.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

D. Locate override controls for exterior site lighting for access by Marine Security Guard immediately adjacent to SVS (Security Video System) control racks such that lighting controls can be operated while directly viewing SVS monitors. See Section 282305 “Security Video System (SVS).”

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 1500 mm (60 inches).
2. Water, Gas, Electric, Communication, and Sewer Lines: 3 m (10 feet).
3. Trees: 5 m (15 feet).

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 150-mm (6-inch) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 25 mm (1 inch) below top of concrete slab.

E. Raise and set poles using web fabric slings, not chain or cable.

3.3 PHYSICAL SECURITY INSTALLATION REQUIREMENTS FOR POLES

A. Foundations for light poles shall not protrude above the finished grade more than 150 mm.

3.4 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 100 mm (4 inches) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 100 mm (4 inches) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION INSTALLATION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.25-mm (0.010-inch) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 GROUNDING

A. Ground metal poles and support structures according to Section 260525 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Section260525 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.

3. Ground metallic components of pole accessories and foundations.

3.8 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.9 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.
2. Comply with one of the following set of testing guide(s):

a. IES:

1) [IES LM-5, "Photometric Measurements of Area and Sports Lighting."]
2) IES LM-50, "Photometric Measurements of Roadway Lighting Installations."
3) IES LM-52, "Photometric Measurements of Roadway Sign Installations."
4) IES LM-64, "Photometric Measurements of Parking Areas."
5) IES LM-72, "Directional Positioning of Photometric Data."

b. British Standard:

1) BS EN 13032-2, “Light and Lighting Measurement and Presentation of Photometric Data of Lamps & Luminaires – Part 2 Presentation of Data for Indoor and Outdoor Workplaces.”

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.10 [REPAIRS

A. **Steel Lighting Poles: Repair minor dents. Touch-up paint at repaired surfaces and where finish has been scratched or chipped.]**

END OF SECTION 265600

SECTION 270508 – COMMON WORK RESULTS FOR TELECOMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the common requirements associated with providing the telecommunications system.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety,” including on common work results for electrical and communications supports and anchors.
2. Section 270526 “Grounding and Bonding for Communications Systems.”
3. Section 270528 “Surface-Mounted Raceways for Communications Systems.”
4. Section 270553 “Identification for Communications Systems.”
5. Section 270645 “Schedules for Audiovisual Systems.”
6. Section 271113 “Communications Entrance Protection.”
7. Section 271116 “Communications Cabinets and Frames.”
8. Section 271119 “Communications Terminations Blocks and Patch Panels.”
9. Section 271123 “Communications Cable Management and Ladder Rack.”
10. Section 271305 “Communications Backbone Cabling.”
11. Section 271505 “Communications Horizontal Cabling.”
12. Section 271543 “Communications Faceplates and Connectors.”
13. Section 272129 “Data Communications Switches and Power Supplies.”
14. Section 274100 “Audiovisual Systems General Requirements.”
15. Section 274114 “Architecturally-Integrated Audiovisual Elements.”
16. Section 274117 “Projection Screens and Projector Lifts.”
17. Section 275105 “Audio Systems for Consular Services.”
18. Section 275118 “Sound Masking.”
19. Section 275405 “Consular Queue Management System Infrastructure and Displays.”

1.2 REFERENCE STANDARDS

A. American National Standards Institute/ Telecommunications Industry Association/ Electronic Industries Alliance (ANSI/TIA):

1. ANSI/TIA Standard 526-7: Measurement of Optical Power Loss of Installed Single- Mode Fiber Cable Plant.
2. ANSI/TIA Standard 526-14: Optical Power Loss Measurement of Installed Multi-Mode Fiber Cable Plant.
3. ANSI/TIA Standard 568.0: Generic Telecommunications Cabling for Customer Premises.

4. ANSI/TIA Standard 568.1: Commercial Building Telecommunications Infrastructure Standard Part 1: General Requirements.
5. ANSI/TIA Standard 568.2: Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
6. ANSI/TIA Standard 568.3: Optical Fiber Cabling and Components Standard.
7. ANSI/TIA Standard 569: Telecommunications Pathways and Spaces.
8. ANSI/TIA Standard 570: Residential Telecommunications Infrastructure Standard.
9. ANSI/TIA Standard 598: Optical Fiber Cable Color Coding.
10. ANSI/TIA Standard 606: Administration Standard for Commercial Telecommunications Infrastructure.
11. ANSI/TIA Standard 758: Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

B. American National Standards Institute Joint Technical Committee (ANSI/JTC):

1. ANSI/TIA Standard 607-D including 607-D-1 Addendum (or later editions): Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

C. American National Standards Institute/ Building Industry Consulting Service International (ANSI/BICSI):

1. ANSI/BICSI N1: Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure.

D. Building Industry Consulting Service International (BICSI):

1. BICSI Telecommunications Distribution Methods Manual.

E. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE C2: National Electrical Safety Code.

F. International Organization for Standardization/ International Electrotechnical Commission (ISO/IEC):

1. ISO/IEC-11801 Information Technology: Generic Cabling for Customer Premises (and all addenda)

G. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code. Refer to Article on QUALITY ASSURANCE for applicable OBO amended version, the OBO Electrical Code.

1.3 SUBMITTAL

A. This Section only identifies those construction submittals that are required to be submitted for the telecommunications system as a whole. Refer to individual Division 27 Sections for those submittals such as Product Data that is related specifically to the work of individual Sections

B. Shop Drawings:

1. General: Shop drawings depict means and methods for installation. Coordinate shop drawings with other disciplines.
2. Grounding and Bonding Plans: Plans at 1:20 scale. Based on Field Quality Control Testing, provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to record of tests and observations. Indicate number of rods driven, their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Maximum valve of ground resistance is 10 ohms. Refer to Section 270526 "Grounding and Bonding for Communications Systems."
3. Cable Routing Schematics: Schematic Section. Refer to Section 271305 "Communications Backbone Cabling."

    a. Indicate general routing of each cable type from termination point to termination point. Identify type and number of strands/pairs for each cable.

4. Telecom Outlet Floor Plans: Plans at 1:20 scale. Refer to Section 271505, "Communications Horizontal Cabling."

    a. Plans for all floors indicating all telecom outlets, including information provided in Preliminary submittal identified below. Each outlet shall be labeled with same identifications as labeled on actual faceplate. As applicable, identify specific areas of floors that are served by individual telecommunications equipment spaces.
    b. Preliminary Submittal: Submit accurate draft of this plan prior to PBX (Telephone Equipment Room) installation showing telecom outlets with final jack numbers at all floors; this draft may be hand-written as long as it is legible.
    c. Coordinate telecom furniture in-feeds with OBO Interiors, the general contractor's interiors discipline, and the installer. In-feed locations shall be unobstructed and accessible.

5. Wireless Plans:

    a. Preliminary Submittal: Submit accurate draft of the WLAN plan prior to installation showing WAP/WAP outlets with final jack numbers on all floors.
    b. Shop drawings shall have a report (showing signal strength) along with propagation drawings showing locations of outlets for WAP's with anticipated signal strength.

6. Layout Plans for Telecommunications Equipment Spaces (e.g., TRs, JUCR): Plans at 1:10 scale. Refer to Section 270528 "Surface-Mounted Raceways for Communications

System," Section 271119 "Communications Termination Blocks and Patch Panels," and Section 271113 "Communications Entrance Protection."

a. Plans for each telecommunications equipment space. Indicate required clearances and accessories, and relationship with adjacent materials.
b. Layout for service entrance spaces where entrance protection will be installed.

7. Cabinet Elevations: Elevations at 1:10 scale. Refer to Section 271116 "Communications Cabinets and Frames," Section 271123 "Communications Cable Management and Ladder Rack," Section 271505 "Communications Horizontal Cabling," and Section 272129 "Data Communication Switches and Power Supplies."

a. Detailed elevation drawings of each equipment cabinet in telecommunications equipment spaces.

8. Wall Elevations: Elevations at 1:10 scale. Refer to Section 271119 "Communication Termination Blocks and Patch Panels," Section "Communications Backbone Cabling," and Section 271505 "Communications Horizontal Cabling."

a. Detailed elevations of wall field terminations and block/wire management for each backboard in each of the telecommunications equipment spaces.

9. Materials Schedule: Refer to Section 271123 "Communications Cable Management and Ladder Rack," Section 271505 "Communications Horizontal Cabling," and Section 272129 "Data Communication Switches and Power Supplies."

a. Identify telecom equipment that will be used at each telecommunications equipment space including manufacture, part number, name, quantities, and function.

C. Qualification Documents: Documentation in support of qualifications identified in Article on QUALITY ASSURANCE. Submit qualification documents concurrently with Product Data and Shop Drawings submittals.

1. Submit copies of required RCDD, BICSI, and original equipment manufacturer (OEM) certifications.
2. Submit list identifying Installation Technicians. Sort list according to those with BICSI or OEM certification, and those who will receive Contractor-managed training.
3. Identify BICSI certified individual on Installer's staff that will manage and monitor Contractor-managed training of Installation Technicians.
4. Submit copies of the required Avixa Certifications for Certified Technology Specialist Designer (CTS-D) and Certified Technology Specialist-Installation (CTS-I), and Original Equipment Manufacturer (OEM) certifications.
5. Submit copies of documentation confirming Ekahau Designer (ECSE) experience as required in the Article on QUALITY ASSURANCE.
6. Submit list identifying Installation Technicians. Sort list according to those with CTS-D, CTS-I or OEM certification, and those who will receive Contractor-managed training.

7. Identify the Avixa certified individual on Installer's staff who will manage and monitor Contractor-managed training of Installation Technicians.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Telecom Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of Registered Communications Distribution Designer (RCDD) with a minimum of ten years of experience designing cabling systems; the ten years shall be within the last fifteen years. Shop drawings shall be prepared in accordance with ANSI/TIA or ISO/IEC standards.
2. Telecom Installation Supervision: Installation shall be under the direct supervision of BICSI Registered Technician who shall be present at all times when Work of this Section is performed at Project site.
3. Telecom Installation Technicians: Fifty percent of installation technicians assigned to this project shall be certified by BICSI or Original Equipment Manufacturer (OEM) at Installer Level Copper (INSTC) or Installer Level Fiber (INSTF). Untrained technicians assigned to this project shall receive Contractor-managed training for skill sets associated with their specific telecommunications work at no cost to Government; management of this training shall be performed by individual on Installer's staff with BICSI certification at Registered Technician or Installer INSTC /INSTF level.
4. Audio Visual (AV) Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of Avixa Certified Technology Specialist - Designer (CTS-D) with a minimum of ten years designing AV systems; the ten years shall be within the last fifteen years. Shop drawings shall be prepared in accordance with ANSI/TIA or ISO/IEC standards.
5. Preparer of Wireless Drawings and Reports: Preparation of Shop Drawings shall be under the direction of an Ekahau Designer (ECSE) or higher with a minimum 5 years' experience with installation and analyzing wireless network infrastructure using Ekahau Pro.
6. AV Installation Supervisor: Installation shall be under the direct supervision of Avixa Certified Technology Specialist-Installation (CTS-I).
7. AV Installation Technicians: Fifty percent of installation technicians assigned to this project shall be certified by Avixa or Original Equipment Manufacturer (OEM). Untrained technicians assigned to this project shall receive Contractor-managed training for skill sets associated with their specific AV work at no cost to the Government. Management of this training shall be performed by an individual on the installer staff with Avixa CTS-D or CTS-I certification.

B. Comply with the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO."

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver assemblies, components, and accessories to job site in undamaged factory packaging.

B. Inspect all items upon delivery to job site.

C. Storage of active equipment, including but not limited to OpenNet switches:

1. Do not deliver to site more than six months prior to final commissioning.
2. Store in temperature-controlled room or container in accordance with manufacturer's recommendations.

D. Store fiber optic cabling, fiber consumables, electronics, and batteries away from moisture, dust, and static electricity.

1. Store these items in location that maintains temperature between 10 deg C (50 deg F) and 30 deg C (85 deg F), and humidity between 30 and 70 percent.

1.6 PROJECT CONDITIONS

A. Due to the sensitive nature of telecommunications components, telecommunications items identified above as requiring environmentally controlled storage shall only be installed when environmental controls and power are operational to maintain those environmental conditions in spaces where those items are installed, and other work in those spaces is approximately 90 percent complete.

1.7 COORDINATION

A. Coordinate layout and installation of voice and data communication cabling with Government-Furnished telecommunications equipment and furniture installation. In-feed locations shall be unobstructed and accessible.

B. Adjust arrangements and locations of distribution frames, cross-connects, UPS, client switches and patch panels in each telecommunications equipment space to accommodate and optimize arrangement and space utilization as approved by Project Director/COR based upon input from OBO/PDCS/DE/EE/CBT.

C. Coordinate the work in this section with other sections as required ensuring that the entire work will be carried out in orderly, complete, and organized fashion.

PART 2 - PRODUCT

2.1 BLUETOOTH FUNCTION IN TELECOMMUNICATION EQUIPMENT

A. Near field communication technologies (e.g., Bluetooth) are prohibited.

PART 3 - EXECUTION

3.1 WLAN FUNCTION IN TELECOMMUNICATION EQUIPMENT

A. Disable WLAN (WiFi), auto answering, and far end remote control on all telecommunications equipment and devices prior to installation.

END OF SECTION 270508

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes grounding of telecommunications systems components and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:

1. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
2. Section 260525 “Grounding and Bonding for Electrical Systems.”
3. Section 264115 “Lightning Protection.”
4. Section 270508 “Common Work Results for Telecommunications.”
5. Section 271113 “Communications Entrance Protection” for additional communications grounding and bonding.
6. Section 337105 “Underground Ducts and Raceways” for ground test wells.

C. REFERENCE STANDARDS

D. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency and testing agency’s field supervisor.

C. Shop Drawings: See Section 270508 “Common Work Results for Telecommunications.”

D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance.”

a. Tests shall be conducted in accordance with section 260252 to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they fail to conform.
b. Identify recommended testing interval periods.

1.3 QUALITY ASSURANCE

A. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

B. Comply with the OBO Electrical Code; see Section 270508 “Common Work Results for Telecommunications.”

C. Comply with UL 467.

D. Comply with IEEE C2 for overhead-line construction and medium-voltage underground construction.

E. Comply with NFPA 780, “Standard for the Installation of Lightning Protection Systems” and UL 96 when interconnecting with lightning protection system.

F. Comply with ANSI/ TIA Standard 607-D including the 607D-1 and all addendums.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded copper cable.

E. Copper Bonding Conductors for Communications: As follows:

1. From Primary Bonding Busbar (PBB) to service equipment ground (power): Minimum 95 mm^2 insulated copper conductor.
2. Telecommunications Bonding Backbone (TBB): Minimum 70 mm^2 insulated copper conductor.
3. Bonding Backbone Conductor (BBC): Minimum 35 mm insulated copper conductor.
4. Telecommunications Equipment Bonding Conductor (TEBC): TEBC connects the PBB/SBB to equipment racks/cabinets within the same room. TEBC shall be continuous copper conductor and shall not be less than #6AWG (18mm) with green insulated jacket.

F. PBB/SBB Bare, annealed copper bars of rectangular cross section, with insulators as shown on drawings.

2.2 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Compression Connectors: Do not use bolted-pressure type; use only permanent and irreversible compression type.

C. Welded Connectors: Exothermic-welded types, in kit form, and selected per manufacturers written instructions.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors.

B. In raceways, use insulated equipment-grounding conductors.

C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

D. Primary and Secondary Bonding Busbar (PBB and SBB) for Communications: Install in telecommunications equipment rooms, telecommunications rooms, telecommunications spaces, and elsewhere as indicated.

1. Use insulated spacer; space 25 mm from wall and support from wall 150 mm above finished floor, unless otherwise indicated.
2. At doors, route bus up to top of doorframe, across top of doorway, and down to specified height above floor.
3. Maintain a bending radius of no less than 10 x Diameter of cable.
4. Cabinets, Racks, and other enclosures shall have their own dedicated bonding conductor to the SBB, PBB or Telecommunications Equipment Bounding Conductor (TEBC).

5. Bonding Backbone Conductor (BBC) shall be green and yellow in color and bonded together with TBB at top floor and at lower level.
6. Install TBB and BBC without splices unless prior written approval is obtained through the COR from OBO/PDCS/DE/EE. When splices are necessary, they shall be minimal in quantity, accessible, and located in telecommunications spaces.
7. Size the PBB and SBB to include attachment spare capacity for four (4) future attachments by the government.
8. Install a minimum 100 mm x 600 mm x 6.4 mm (4” x 24” x ¼” (.25”)) Primary Bonding Busbar (PBB) in Telecommunications Service Entrance Facility (TSEF) such that it is accessible to telecommunications and building facilities personnel.
9. Install a minimum 100 mm x 300 mm x 6.4 mm (4” x >12” x 0.25”) Secondary Bonding Busbar (SBB) with grounding conductor that is not less than 70 mm2 (#2/0) in cross sectional area.
10. The Secondary Bonding Conductor (SBC) and the BBC shall be the same size and type as the TBB. The Telecommunications Bonding Conductor (TBC) shall be at a minimum, the same size as the TBB.
11. Routing shall be continuous, short, and as straight as possible.
12. Install a minimum 19.1 mm x 508 mm x 4.763 mm (.75” x 19” x 3/16” (0.1875”)) busbar at the base or top of each Cabinet/Rack and each CO-Location cabinet compartment for consolidating equipment bonding conductors.
13. Homerun the Bonding Conductor from each Cabinet/Rack Busbar to the closest PBB/SBB or TEBC. Connect with 2-hole lugs on all PBB, SBB, and Rack mounted Busbars (RBB).
14. The minimum size for the TEBC, rack bonding conductor, telecommunications raceways, or any other telecom equipment shall be 6 AWG.
15. Exposed Building Structural Steel in the Telecom Room shall be connected to the Telecommunications Grounding/Bonding Infrastructure with exothermic welded connections. Mechanical and compression connections are not permitted to the exposed structural steel in the Telecom Rooms.
16. Do not use interior water piping system, metallic cable shield, metallic conduit, trunking, cable tray, or cable ladder as a BBC. BBC shall be a dedicated conductor.

E. Underground Grounding Conductors: Use bare-copper conductor, 95-mm^2 minimums. Bury at least 600 mm below grade or bury 300 mm above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with Article 250 of the model NFPA 70 for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Code are indicated.

B. Comply with TIA Standard 607-D including the 607D-1 and all addendums

C. For alarm, voice, data, and other communication systems, provide insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, telecommunications rooms, equipment rooms, and central equipment location.

1. Terminate grounding conductor on a minimum 6.4-by-100-by-300-mm grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding bus bar/terminal.

D. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor with same size as system grounding electrode conductor and install in conduit.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

C. Metal Water Service Pipe: Do not connect to communications ground system.

D. Water Meter Piping: Do not connect to communications ground system.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturers written instructions. Welds that are puffed up or that show convex surface indicating improper cleaning are not acceptable. Refer to Section 260525 “Grounding and Bonding for Electrical Systems” for acceptable locations for exothermic-welded connections.

C. Equipment Grounding Conductor Terminations: Use pressure-type grounding lugs; winged pressure-type connectors shall not be used.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with grounding bushing. Connect grounding bushings with bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make visible indication that connector has been adequately compressed on grounding conductor. Refer to Section 260525 “Grounding and Bonding for Electrical Systems” for acceptable locations for compression-type connections.

G. Use only two hole lugs for connections to Secondary Bonding Busbar (SBB), Primary Bonding Busbar (PBB), Rack Bonding Busbar and ladder racks.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Duct Banks: Install 16 mm^2 (#6 AWG) copper ground wire, run parallel to conduit within concrete encasement.

B. Manholes and Hand-holes: Install driven ground rod close to wall and set rod depth so 100 mm will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 70mm^2 bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 50 mm above to 150 mm below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or hand-hole, to ground rod or grounding conductor. Make connections with 25 mm^2 minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.6 FIELD QUALITY CONTROL

A. Engage qualified testing agency to perform the following field quality-control testing:

B. Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements. The maximum resistance at any point in the system shall be 5 ohms or less.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after last trace of precipitation, and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by fall-of-potential method in accordance with IEEE 81.
3. Excessive Ground Resistance: If resistance to ground exceeds specified values, drive additional ground rods until resistance meets specified values.
4. Provide test results to OBO/PDCS/DE/EE via the COR in a table format for each of the following locations:

    a. Roof grounding system of the office building, East, West, North and South.
    b. Telecom Rooms (TR) each TR on the compound, Test PBB/SBB and each cabinet RBB.
    c. Telecom Equipment Room/Systems Room, on the compound, Test PBB/SBB and each cabinet RBB.

END OF SECTION 270526

SECTION 270528 – SURFACE-MOUNTED RACEWAYS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies raceway and wiring distribution systems, including the following:

1. Surface raceways.

B. Related Sections: Other Specification Sections which directly relate to the work of this Section include, but are not limited to, the following:

1. Division 07 Section on penetration firestopping.
2. Section 260525 “Grounding and Bonding for Electrical Systems.”
3. Division 26 Section on raceways and boxes.
4. Section 270508 “Common Work Results for Telecommunications.”
5. Section 270526 “Grounding and Bonding for Communications System.”
6. Section 270553 “Identification for Communications Systems.”
7. Section 271305 “Communications Backbone Cabling.”
8. Section 271505 “Communications Horizontal Cabling.”
9. Section 271543 "Communications Faceplates and Connectors.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product data including specifications and installation instructions for each item. Include methods of installation and requirements for substrate preparation. Include data substantiating that materials comply with specified requirements.

B. Samples: Submit 150 mm (6 inch) lengths of exposed type surface raceways with required color and finish. Show standard color ranges available.

C. Shop Drawings: See Section 270508 “Common Work Results for Telecommunications.”

D. Maintenance Data: Provide manufacturer's maintenance data for all components of system.

E. Qualifications Documents: See Section 270508 “Common Work Results for Telecommunications.”

1.4 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of raceway systems, boxes and fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than ten years.

B. Standards Compliance: Comply with requirements of applicable local codes, UL, and NEMA Standards pertaining to raceways, boxes and fittings. Provide raceways, boxes and fittings which have been UL listed.

C. Installer Qualifications: See Section 270508 “Common Work Results for Telecommunications.”

D. Comply with the OBO Electrical Code; see Section 270508 “Common Work Results for Telecommunications.”

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 “Common Work Results for Telecommunications.”

1.6 COORDINATION

A. See Section 270508 “Common Work Results for Telecommunications.”

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Wiremold 4000 Series Steel Raceway.

2.2 SURFACE RACEWAYS

A. General:

1. System: Provide surface raceway systems for communications and low voltage wiring where indicated on drawings and in criteria. Surface raceway system shall consist of

raceway bases, covers, appropriate fittings and device mounting plates necessary for complete installation.

2. Configuration: Raceways shall be one- or two-piece design with base and snap-on cover, or three-piece design with base and two snap-on covers which snap side by side on common base. Base shall be dividable with fixed barrier for up to four compartments. Raceway shall be available in widths of 19 mm (3/4 inch) to 250 mm (10 inch), and depths of 13 mm (17/32 inch) to 125 mm (5 inch). Provide raceways from company which can provide custom sizes if required. Raceway covers shall be available in tamper-resistant form with screws on access plates and covers of fittings, but not on standard cover lengths.
3. Fittings: Fittings shall include flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Where required, provide tamper-resistant form, dividable with barriers and matching the size of the accompanying raceway base. Provide full capacity corner elbows and tee fittings to maintain controlled 50 mm (2-inch) cable bend radius, meeting the specification for communications horizontal cabling and communications backbone cabling and exceeding ANSI/TIA Standard 569.
4. Device Brackets and Plates: Provide in sizes to match the raceway width and with mounting holes located to ensure proper mounting of devices in up to four compartments. Device plates shall be available in any length from 150 mm (6 inch) to 1500 mm (60 inch), with cutouts to accommodate various combinations of power and communications devices in up to four compartments. Provide 150 mm (6 inch) and 300 mm (12 inch long) device plates with flange to overlap joint of adjacent cover as applicable.
5. Communications Devices and Accessories: Raceway shall accommodate complete line of connectivity outlets and modular inserts for copper UTP, fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts.

B. Classification and Listing:

1. Raceway and system components shall be UL and CUL listed.
2. Surface raceways shall be suitable for use in dry interior locations only, in accordance with requirements for surface metal raceways in the OBO Electrical Code.
3. Surface metal raceways and fittings shall be listed by Underwriters Laboratories under File Number E4376, Listing and Classification Number RJBT and File Number E41751, Listing and Classification Number RJPR respectively.
4. Systems shall comply with UL Standard UL5 for Surface Metal Raceways.

C. Surface Mounted Steel Raceways:

1. Material: Galvanized steel, minimum thickness 1 mm (0.040 inches).
2. Finish: Basis of Design is Manufacturer's standard ScuffCoat. Gray or ivory color, as approved by Project Director/COR.
3. Steel Device Brackets and Plates: Steel overlap device plate for horizontal installation of devices. Plate shall overlap cover to conceal seam.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions under which raceways, boxes, distribution systems, accessories, and fittings are to be installed and substrate that will support raceways. Notify the Project Director/COR in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.

1. Mechanical Security: : Raceway systems shall be mechanically continuous and connected to all outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer’s installation sheets.
2. Electrical Security: Metal raceway shall be electrically continuous and bonded in accordance with the OBO Electrical Code for proper grounding.
3. Raceway Support: Raceway shall be supported at intervals not exceeding 1500 mm (5 feet) or in accordance with manufacturer’s installation sheets.
4. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.
5. Unused Openings: Close unused raceway openings using manufacturer's recommended accessories.

3.3 CLEANING AND PROTECTION

A. Fiber Optic Termination Points: Install warning notice about risk of eye damage.

B. Protect raceways and boxes until acceptance.

END OF SECTION 270528

SECTION 270553 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the furnishing and installation of all necessary materials and services required for proper labeling of telecommunications cabling systems.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications and Electronic Safety” for supports, anchors, and identification products.
2. Division 26 Section on cable trays.
3. Section 270508 “Common Work Results for Telecommunications.”
4. Section 270526 “Grounding and Bonding for Communications Systems.”
5. Section 270528 “Surface-Mounted Raceways for Communications Systems.”
6. Section 271113 “Communications Entrance Protection.”
7. Section 271116 “Communications Cabinets and Frames.”
8. Section 271119 “Communications Terminations Blocks and Patch Panels.”
9. Section 271123 “Communications Cable Management and Ladder Rack.”
10. Section 271305 “Communications Backbone Cabling.”
11. Section 271505 “Communications Horizontal Cabling.”
12. Section 271543 “Communications Faceplates and Connectors.”
13. Section 272129 “Data Communications Switches and Power Supplies.”
14. Section 337105 “Underground Ducts and Raceways.”
15. Section 275105 “Audio System Consular.”
16. Section 275405 "Consular Queuing System.”
17. Section 275118 “Sound masking.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTALS

A. Product Data: For all identification materials.

B. Samples: For all identification materials. Sample shall include alphanumerical characters on label ID that contractor proposes to use. Character on label ID shall be as large as practical without need of using magnified glass to read. Provide reference scale with each sample.

C. Qualification Documents: See Section 270508 "Common Work Results for Telecommunications."

D. Cable Administration Record:

1. Provide in MS Excel Spreadsheet format.
2. Printed copy shall be in separate binders for each system located in telecommunications equipment spaces.
3. Locate binders within cabinets and attach them with lightweight metallic chain for each corresponding system.
4. Post in prominent location in each telecommunications equipment spaces.
5. List incoming and outgoing cables and their designations, origins, and destinations.
6. Protect each sheet in plastic sheet protector.
7. Provide at least five additional sheet protectors in each binder.
8. Furnish electronic copy or final comprehensive schedules for Project, in MS Excel format.

E. Cable Administration Drawings:

1. Show building floor plans with cable administration point labeling. Identify labeling convention and show labels for telecommunications equipment spaces, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention or ANSI/TIA Standard 606. Furnish electronic record of all drawings, in software and format selected by Project Director/COR.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: See Section 270508 "Common Work Results for Telecommunications."

B. Comply with the OBO Electrical Code; see Section 270508 "Common Work Results for Telecommunications."

C. Each outlet on the as-built drawings shall be labeled with the same identification as labeled on the actual faceplate.

PART 2 - PRODUCTS

2.1 LABELING SYSTEM FOR EQUIPMENT, CABLES, PATCH PANELS AND OUTLETS

A. Basis of Design: Products from the following manufacturer represent the Basis of Design; Equivalent products from other manufacturers may be used, as approved by the Project Director/COR.

1. Tyton.
2. Brady.

B. Labels:

1. Self-laminating, smear resistant, permanent, and machine lettered (not handwritten) shall be used for all telecommunications and audio/visual systems described in division 27.

C. Labeling convention shall be in accordance with ANSI/TIA Standard 606.

2.2 COLOR CODED IDENTIFICATION SYSTEM

A. OSP Fiber Optic Distribution (Backbone) Cabling Identification:

1. Finished fibers shall be color-coded by Manufacturer for identification.

B. OSP UTP Copper (Backbone) Cabling Identification:

1. Identify binder groups and individual pairs using industry standard color codes.
2. Cable shall comply with ANSI/ICEA S-80-576 for standard U.S. color codes and binder color-code integrity.

C. Inside Building Copper Backbone/Riser Cable Identification:

1. Cable shall comply with ANSI/ICEA S-80-576 color for standard U.S. color codes and binder color code integrity.

D. Inside Building Fiber Optic Backbone/Riser Cable Identification:

1. Cable shall comply with ANSI/TIA Standard 598. Finished fibers shall be color-coded by Manufacturer for identification.

E. Horizontal Fiber Optic Cable Identification:

1. Different color sheaths are required for horizontal fiber optic cables. Refer to separate contract attachment J.3.5 for color code requirement for each type of network that requires fiber optic cables at faceplate. Use white color for all unclassified horizontal cables,

F. UTP Horizontal Distribution Cable Identification:

1. Different color sheaths shall distinguish Cables for voice, data, spare, CATV, and AV. Voice (telephone) cable shall be blue. OpenNet cable shall be orange. Spare 1 cable shall be green, CATV cable shall be purple, AV cable shall be gray, and WLAN shall be yellow for outlets outside the CAA. For outlets inside the CAA: Voice cable shall be blue, OpenNet cable shall be orange, Spare 1 cable shall be green, Spare 2 cable shall be yellow, CATV cable shall be purple, and AV cable shall be gray.
2. WLAN outlets above the ceiling shall be identified with the ceiling grid. Provide labels on the architectural ceiling directly below the wireless outlet. Ceiling grid label color shall be yellow, self-laminating, smear resistant, permanent, and machine lettered.
3. All cables for Audio/Visual (A/V) system shall be gray.

G. F/UTP Horizontal Distribution Cable Identification:

1. At the TV outlet, F/UTP cable shall be purple .

H. Modular Jack Identification:

1. Modular jack connectors for voice shall be blue.
2. Modular jack connectors for OpenNet shall be orange.
3. Modular jack connectors for Spare 1 shall be green.
4. Modular jack connectors for WLAN shall be yellow outside the CAA.
5. Modular jack connectors for Spare 2 shall be yellow inside the CAA.
6. Modular jack connectors for Television shall be purple.
7. Modular jack connectors for A/V shall be gray.

I. Grounding conductor and busbar:

1. Outer jacket for grounding conductor shall be green. For large conductor, where green jacket is not available, use green tape wrapping at both ends of cable.
2. Warning Label: Provide yellow warning label at telecom grounding busbar in telecom rooms and equipment rooms. Label shall include the following information below:

FIGURE 2.2 – BUSBAR WARNING LABEL

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CONTACT IMO/ISO

PART 3 - EXECUTION

3.1 INSTALLATION

A. In addition to requirements in this Article, comply with applicable requirements in Division 26 Section on identification for electrical systems and ANSI/TIA Standard 606.

B. Cabinets and Frames: Label each unit and field within that unit.

C. Within Connector Fields in Telecommunications Equipment Spaces: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

D. Cables:

1. General: Label each cable within 100 mm of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated. Include alphanumeric labeling for designation, origin, destination, and cable type.
2. Exposed Cables, and Cables in Cable Trays and Wire Troughs: Label each cable at each end.
3. Workstation: Label cables within outlet boxes.

E. Warning Notices:

1. Fiber Optic Termination Points: Install warning notice about risk of eye damage.
2. Provide placards for RF hazard on rooftop access doors, hatches, and at a safe distance from ground mounted RF systems.

END OF SECTION 270553

SECTION 270645 – SCHEDULES FOR AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes schedules for audiovisual (A/V) systems identified in other Sections.

B. Related Sections include the following:

1. Section 274100 “Audiovisual Systems General Requirements.”
2. Section 274114 “Architecturally-Integrated Audiovisual Elements.”
3. Section 274117 “Projection Screens and Projector Lifts.”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE

A. The Schedules in this Section identify typical space types which incorporate specific types of A/V item; the project-specific presence of these space types or the presence of other space types with A/V components is identified elsewhere.

1. Item names correlate with paragraph headings within referenced A/V specification sections.
2. Items identified within schedules as Contractor-Furnished Contractor-Installed (CFCI): Contractor shall provide both scheduled A/V components and associated infrastructure to that location. Where scheduled element is an operational (e.g., flat panel display), provide all components necessary for functioning element.
3. Items identified within schedules as Government-Furnished Government-Installed (GFGI/OFOI): Contractor shall only provide associated infrastructure for scheduled A/V system (e.g., cable pathway, associated A/V and power outlets); Government will furnish and install scheduled A/V system itself, including A/V cabling.

B. Schedules for A/V systems in Outdoor Compound Event Areas: The specific areas (e.g., play fields, pool deck area) with A/V system components are identified elsewhere.

1. CFCI Components: Loudspeaker and A/V connection, A/V controls, amplifiers, and all components necessary for a completely functional system.

a. Provide empty 50-mm conduit from location serving outdoor events to nearest Telecom Room (TR).

C. Schedules for A/V Systems in Outbuildings: A/V components are associated only with outbuildings which include space types such exercise or activity spaces. For example, those scenarios are present within expanded Recreational Facilities (i.e., facilities that are not limited to Cabana/Rec function), and within common spaces of Community Center buildings (e.g., lounges, game rooms).

1. CFCI Components: Wall mounting device to receive flat panel displays, and A/V connection, flat panel displays, A/V controls and amplifiers.

D. Schedules for A/V Systems in Residential Buildings/Spaces:

1. MSGR:

a. Living/Meeting Room CFCI Components: Wall mounting device to receive flat panel displays, and A/V connection, Flat panel displays, A/V controls, amplifiers, and other A/V devices necessary for a completely functional system.
b. Patio CFCI Components: Floor box above ground level (e.g., attached on post), loudspeakers, and A/V connection, A/V Controls

1) Provide empty 50-mm conduit from patio to MSGR Telecom Room (TR).

2. Non-representational Residences (SDA/Housing) Dwelling Unit Spaces: In Living Room, Den, and each bedroom:

a. CFCI Components: A/V connection.
b. GFGI Components: Furniture-mounted flat panel displays, A/V controls, and other A/V devices (e.g., multi-format disk players).

3. Non-representational Residences (SDA/Housing) Common Area Spaces: In spaces such as Recreation Room, Lounge, Game Room, and TV Room.

a. CFCI Components: Wall mounting device to receive flat panel displays, amplifiers, and A/V connection Wall-mounted flat panel displays, controls, and other A/V devices necessary for a completely functional system.

4. Representational Residences like CMR and DCMR: In Reception Room, Salon, Library, Parlor, Social Secretary's Office, Family Room, Study, and each bedroom.

a. CFCI Components: Wall mounting device to receive flat panel display in Reception Room. A/V input/output/Bluetooth connection plates. Wireless microphone system and ceiling or wall mounted speakers for Reception/Salon area. Provide 1 coax and 1 CAT X for all TV locations in addition to voice, data, and Wi-Fi (WLAN) cabling throughout each residence.

b. CFCI Components (except bedrooms): Wall-mounted or furniture mounted flat panel displays, A/V controls, and other A/V devices necessary for a completely functional system in each room.
c. All headend hardware shall be mounted in designated A/V rack
d. Outdoor garden speakers shall be provided.
e. Two background music media players shall be installed in A/V rack
f. Pavilion and rest rooms shall be getting ceiling speakers for background music.

E. Schedules for A/V Systems in Office Buildings:

1. Attachment A “Schedule of Audiovisual Infrastructure in Office Buildings.”
2. Attachment B “Schedule of Audiovisual Display Equipment in Office Buildings.”
3. Attachment C “Schedule of Audio Systems in Office Buildings.”
4. Attachment D “Schedule of Audiovisual Presentation Source and Transmission Equipment in Office Buildings.”

END OF SECTION 270645

ATTACHMENT A – AUDIOVISUAL INFRASTRUCTURE IN OFFICE BUILDINGS

ITEM	NOTES	Small Conf/ Team Room	Med Conf	Large Conf	Classroom	Breakroom	Lactation Room	MPR	AV Control Booth	American center	CLO Ref Meeting	Gallery/ Atrium	Cafeteria Dining Rm	Exercise Room	COM/ DCM Office	MSGR Rec Room	MSGR Patio
A/V Control Processors Section 274114		n/a	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	CFCI	CFCI	n/a
Floor Boxes Section 274100	Coordinate with power/telecom for space/depth requirements for A/V elements	CFCI	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	CFCI	CFCI	n/a
Furniture Integrated Architectural Connectivity (AAP) Plates & Custom Wall/Floor Box Patch Plates Section 274100		CFCI	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	CFCI	CFCI	CFCI	CFCI
Internal A/V Connection Plates Section 274100		CFCI	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	CFCI	CFCI	CFCI
Equipment Rack & Shelving Section 274100	[1]Millwork/credenza mounted rack [2]Freestanding equipment rack [3]Coordinate with OBO Interior Design	[1]CFCI Furn	[1]CFCI Furn	[1]CFCI Furn	[3]CFCI	n/a	n/a	n/a	[2]CFCI	[1]CFCI Furn	n/a	[3]CFCI	[3]CFCI	n/a	[1]CFCI Furn	[1]CFCI Furn	n/a

ATTACHMENT A – AUDIOVISUAL INFRASTRUCTURE IN OFFICE BUILDINGS

ITEM NOTES	Small Conf/ Team Room	Med Conf	Large Conf	Classroom	Breakroom	Lactation Room	MPR	AV Control Booth	American center	CLO Ref Meeting	Gallery/ Atrium	Cafeteria Dining Rm	Exercise Room	COM/ DCM Office	MSGR Rec Room	MSGR Patio
System Controller or Touch Panel Section 274114	n/a	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	CFCI	CFCI	n/a

ATTACHMENT B – AUDIOVISUAL DISPLAY EQUIPMENT IN OFFICE BUILDINGS

ITEM	NOTES	Small Conf/ Team room	Med Conf	Large Conf	Classroom	Breakroom	Lactation Room	MPR	AV Control Booth	American Center	CLO Ref Meeting	Gallery/ Atrium	Cafeteria Dining Rm	Exercise Room	COM/ DCM Office	MSGR Rec Room	MSGR Patio
Projector Screens Section 274117	[1] Typical screen type is motorized with recessed ceiling mounting; where space above ceiling is limited, use surface mounting; for renovations, fixed wall-mounted screens may be used	n/a	n/a	n/a	n/a	n/a	n/a	[1]CFCI	n/a	[1]CFCI	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Projectors Section 274114	Large-venue video projector	n/a	n/a	n/a	n/a	n/a	n/a	CFCI	n/a	CFCI	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Projector Mounting Sections 274114 and 274117	Typical projector mounting is from suspended from ceiling, with motorized projector lifts only considered for special needs such as some renovation configurations	n/a	n/a	n/a	n/a	n/a	n/a	CFCI	n/a	CFCI	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Flat Panel Displays (FPD) Section 274114		CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)
Display/ Board	Device for flat panel displays (FPD) and Smart Boards (SB); location as	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)	CFCI (FPD)

ITEM	NOTES	Small Conf/ Team room	Med Conf	Large Conf	Classroom	Breakroom	Lactation Room	MPR	AV Control Booth	American Center	CLO Ref Meeting	Gallery/ Atrium	Cafeteria Dining Rm	Exercise Room	COM/ DCM Office	MSGR Rec Room	MSGR Patio
Mounting Device Section 274114	appropriate for room configuration																

ATTACHMENT C – AUDIO SYSTEMS IN OFFICE BUILDINGS

ITEM	NOTES	Small Conf/ Team Room	Med Conf	Large Conf	Classroom	Breakroom	Lactation Room	MPR	AV Control Booth	American Center	CLO Ref Meeting	Gallery/ Atrium	Cafeteria Dining Rm	Exercise Room	COM/ DCM Office	MSGR Rec Room	MSGR Patio
Audio Digital Signal Processors Section 274114		n/a	n/a	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	CFCI	CFCI	CFCI
Assisted Listening System Section 274114	Inclusion of this system is post-specific	n/a	n/a	n/a	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	n/a	n/a	n/a
Power Amplifiers Section 274114	1) Evaluate two-channel program, multi-channel sound reinforcement, or voice reinforcement; 2) Evaluate multi-channel sound reinforcement or voice reinforcement; 3) Evaluate two-channel program or multi-channel sound reinforcement;	n/a	CFCI	[1]CFCI	CFCI	n/a	n/a	[2]CFCI	[3]CFCI	CFCI	n/a	[2]CFCI	CFCI	CFCI	CFCI	CFCI	CFCI

	4) Provide multi-channel sound reinforcement																
Loudspeakers Section 274114	1) Utilize ceiling- or wall-mounting based upon room configuration; 2) Provide wall-mounting	n/a	n/a	[1]CFCI	CFCI	n/a	n/a	[1]CFCI	[1]CFCI	[1]CFCI	n/a	[1]CFCI	CFCI	CFCI	CFCI	CFCI	CFCI
Microphones Section 274114	Coordinate w/ GFE placement of lecterns	n/a	n/a	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	CFCI	n/a	n/a

ATTACHMENT D – AUDIOVISUAL PRESENTATION AND TRANSMISSION EQUIPMENT IN OFFICE BUILDINGS

ITEM	NOTES	Small Conf/ Team Room	Med Conf	Large Conf	Classroom	Breakroom	Lactation Room	MPR	AV Control Booth	American Center	CLO Ref Meeting	Gallery/ Atrium	Cafeteria Dining Rm	Exercise Room	COM/ DCM Office	MSGR Rec Room	MSGR Patio
Audio/Video Transmitters & Receivers Section 274114		CFCI	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	CFCI	CFCI	CFCI	CFCI
Distance Learning & Video Conferencing Section 274114	Post-specific; codec & video capture	Post	Post	Post	Post	n/a	n/a	Post	Post	Post	Post	Post	Post	n/a	Post	n/a	n/a
CATV/IPTV Set Top Device Section 274114		n/a	Post	Post	Post	n/a	n/a	Post	Post	Post	n/a	Post	Post	n/a	Post	n/a	n/a
Matrix Switcher Section 274114		n/a	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	CFCI	n/a	n/a	n/a	n/a
A/V Bridge Section 274114		n/a	n/a	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	n/a	n/a	n/a	n/a	n/a
All-In-One Conferencing Bar		CFCI	CFCI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Section 274114																	
PTZ Conferencing Camera Section 274114		n/a	n/a	CFCI	CFCI	n/a	n/a	CFCI	n/a	CFCI	n/a	CFCI	n/a	n/a	n/a	n/a	n/a
USB Extenders Section 274114	Used for GFGI BYOD and GFGI PC keyboard, mouse, card reader, and USB switchers	CFCI	CFCI	CFCI	CFCI	n/a	n/a	CFCI	CFCI	CFCI	n/a	CFCI	n/a	n/a	n/a	n/a	n/a

SECTION 271113 – COMMUNICATIONS ENTRANCE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered in this section consists of furnishing and installation of all necessary labor, supervision, materials, equipment, tests, and services to install complete cable protection system.

B. Related sections include the following:

1. Division 07 Section on penetration firestopping.
2. Section 260525 “Grounding and Bonding for Electrical Systems.”
3. Section 262725 “Wiring Devices” for devices installed in boxes.
4. Section 264115 “Lightning Protection.”
5. Section 270508 “Common Work Results for Telecommunications.”
6. Section 270526 "Grounding and Bonding for Communications Systems."
7. Section 271305 “Communications Backbone Cabling.”
8. Section 337105 “Underground Ducts and Raceways.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTALS

A. Product Data: Submit manufacturers’ data for entrance protection including but not limited to: entrance protector panels, entrance protectors, termination fields.

B. Shop Drawings: See Section 270508 “Common Work Results for Telecommunications.”

C. Qualifications Documents: See Section 270508 “Common Work Results for Telecommunications.”

1.4 QUALITY ASSURANCE

A. Comply with the OBO Electrical Code; see Section 270508 "Common Work Results for Telecommunications."

B. Comply with NFPA 780, "Standard for the Installation of Lightning Protection Systems."

C. Comply with ANSI/ TIA Standard 607-D including the 607D-1 and all addendum.

D. Panels and protectors must be UL listed.

E. Obtain all components of entrance protection system through one single manufacturer. Match components and interconnection for optimum future performance.

F. Installer Qualifications: See Section 270508 "Common Work Results for Telecommunications."

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 "Common Work Results for Telecommunications."

1.6 PROJECT CONDITIONS

A. See Section 270508 "Common Work Results for Telecommunications."

1.7 COORDINATION

A. Coordinate with electrical power installation for location of the service entrance.

B. Coordinate with local utility for installation of equipment belonging to access and/or service provider.

C. See Section 270508 "Common Work Results for Telecommunications" for additional coordination.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers: Provide equipment from one of the following manufacturers, or manufacturer approved by the Project Director/COR and coordinated with OBO/PDCS/DE/EE.

1. Tii Technologies
2. Approved equal

2.2 PROTECTOR PANELS FOR UTP CABLE

A. Basis of Design: Tii Technologies 24 Series.

B. Protector Panels:

1. Provide protection for communication equipment and circuits exposed to overvoltage and sneak current protection.
2. Utilize 110-type for both input and output cable termination.
3. Size in accordance with incoming and outgoing pair counts.
4. Provide hinged cover with lock to limit access and mechanical protection.
5. Design for use with 5-pin insertion protector unit.
6. Include in-service test points.

2.3 PROTECTOR UNITS FOR UTP CABLE

A. Basis of Design: Tii Technologies 115 Series or equivalent.

B. Max Trip Current: 1.0A within 5 seconds.

C. General Design:

1. Individual with 5-pin plug-in unit.
2. Solid state type to provide overvoltage and sneak current protection.

D. Provide protector units with a clamping time less than 5 nanoseconds.

E. Protector unit shall be able to engage at multiple DC holdover currents and multiple sneak currents.

F. Minimal DC Holdover: 52 V with response time of less than 20 milliseconds.

G. Surge endurance shall be 100A per side.

H. Fast Response Secondary Protectors: UL497A.

2.4 PROTECTOR UNITS FOR COAXIAL CABLE

A. Provide surge protectors with operating temperature from minus 40 deg C to plus 100 deg C.

1. Protectors shall be bi-directional with no signal loss.

B. Provide in-line protectors.

C. Maximum Power at 50 Ohms: 500 watts.

D. Breakdown Voltage at 100 Volts per Second: 200-300 Volts.

E. Residual Voltage at 1 kVolt (U.S.): Less than 600 volts.

F. Power Handling: 10kA at 10 shocks, and 20kA at 1 shock.

G. Return Loss for N Connectors at 1 GHz: Less than minus 25 dB.

H. Insertion Loss for N Connectors at 1 GHz: Less than 0.03 dB.

I. Housing: Copper alloy with CuZnSn finish.

J. Insulation: Teflon per ASTM D-170.

K. Contact Shocks: Gold plated copper alloy or beryllium copper.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check raceways, cable, and other elements for compliance with space allocation, installation tolerances, hazards to cable, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Route associated ground as straight as possible directly to PBB.

B. If protectors are installed in metal box, bond box with approved grounding conductor directly to protector ground.

C. Verify there are no obstructions around or in front of protectors.

D. UTP Protectors:

1. Allow at least 3200 mm^2 per circuit pair for installation of protector units.
2. Install protectors immediately adjacent to exposed cable plant point of entry.
3. Bond the metal sheath of UTP backbone cable with approved grounding conductor to grounding busbar.

E. Coaxial Protectors:

1. Assign maximum voltage according to power rating of equipment.
2. For coaxial protectors, choose appropriate connector type according to application.

END OF SECTION 271113

SECTION 271116 – COMMUNICATIONS CABINETS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered in this section consists of communications cabinets and frames.

B. Related Sections:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
2. Division 26 Section on cable trays.
3. Division 26 Section on vibration and seismic controls for electrical systems.
4. Section 270508 “Common Work Results for Telecommunications.”
5. Section 270526 "Grounding and Bonding for Communications Systems."
6. Section 270553 "Identification for Communications Systems."
7. Section 272129 "Data Communications Switches and Power Supplies."

1.2 REFERENCE STANDARDS:

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.”

1.4 SUBMITTALS

A. Product Data: Provide manufacturer’s literature of telecommunications installation materials.

B. Shop Drawings: See Section 270508 “Common Work Results for Telecommunications.”

C. Qualification Documents: See Section 270508 "Common Work Results for Telecommunications."

1.5 QUALITY ASSURANCE

A. Installer Qualifications: See Section 270508 "Common Work Results for Telecommunications."

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 "Common Work Results for Telecommunications."

1.7 COORDINATION

A. See Section 270508 "Common Work Results for Telecommunications."

PART 2 - PRODUCTS

2.1 GENERAL

A. Open freestanding equipment rack is not permitted.

2.2 EQUIPMENT CABINETS

A. General: Equipment cabinet shall be either freestanding or wall mounting equipment cabinet and size as indicated in Drawings. Equipment cabinet shall be modular steel unit and equipped with the following:

1. Fans for ventilation. Minimum airflow shall be 190 L/s (400 cfm) unless noted otherwise (with concurrence of OBO/PDCS/DE project engineer).
2. Hinged doors with reversible swing and lock for protection.
3. Rails conforming to EIA 310-D standard for mounting standard 482-mm equipment with cage nut style and square hole equipment mounting rails.
4. Grounding busbar kit inside equipment cabinet.
5. Transparent front door and vented rear door.
6. Power strip with surge protection and receptacle outlets on the power strip; minimum of 6 for wall mounted and Co-Location Cabinet sections and 12 for floor mounted cabinets.
7. Vertical wire management extending full height of cabinet including both sides, as well as front and back.
8. Knockouts for cable accessed along top, bottom, or rear panels.
9. Wall-Mounted Cabinets: Provide dual locking hinges for front and back access.
10. Freestanding Cabinets: Accessible from both front and back.

11. Finish: Manufacturer's standard gray if available; otherwise, manufacturer's standard black.

B. Cabinets:

1. Basis of Design:

a. TRs/CAER/CTSEF/RNER/CTF: 2100 mm high x 750 mm wide x 900 mm (84" x 30" x 36").
b. TRs/RNER Colocation (Colo): Two door, 2100 mm high x 750 mm wide x 900 mm deep (84" x 30" x 36").
c. JUCR: 2100 mm high x 750 mm wide x 1067 mm deep (84" x 30" x 42").
d. JUCR Colo: Two door, 2100 mm high x 750 mm wide x 1067 mm deep (84" x 30" x 42").
e. MTER (PBX)/Main CAA voice server cabinet: 2100 mm high x 750 mm wide x 1050 mm (84" x 30" x 42"). PBX cabinet/s shall have minimum usable front to back internal rail depth of 914 mm (36").

2. Perforated reversible front and back door with approximately 63 percent opening,
3. 3-digit combination handle.
4. Lift-off side panels.
5. Finish: Manufacturer's standard **[white][gray][black]**.
6. Seismic Bracing: Provide as required by site-specific seismic rating.
7. Colo Cabinets:

a. Each section shall have locking 3-digit combination handle.
b. Provide fans in all sections of Colo Cabinets.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify manufacturer's installation methods prior to installation; installation shall conform to those methods.

B. Ensure cabinets will fit footprint allocated prior to attempting installation.

C. Plan for space needed for installation of both equipment and cable.

D. Plan equipment installation into cabinet/rack. Ensure that open space recommendations are adhered to for airflow between electronic equipment. Ensure there is adequate space for cable so that bend radius and separation requirements are met.

3.2 INSTALLATION

A. Connect ground busbar in cabinet/rack to SBB or PBB. Cabinets, Racks, and other enclosures shall have their own dedicated bonding conductor to the SBB, PBB or Telecommunications Equipment Bonding Conductor (TEBC).

B. Securely fasten floor mounted cabinets/racks to floor with anchors, expansion bolts, or other suitable anchorage devices. Coordinate with structural engineer for proper type and use of bolts. Do not install concrete bases for communications cabinets and frames.

C. Support top of floor mounted cabinet/rack by bracing it to the wall, support barrier, or ladder rack. Consult seismic engineer when seismic bracing is required.

D. Main Telephone Equipment Room: Remove side panels from cabinets before installation.

E. Telecommunications Room: Where there is more than one voice cabinet in a TR, remove side panels between cabinets before installation.

END OF SECTION 271116

SECTION 271119 – COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes materials but not limited to wires, connecting devices, and miscellaneous items associated with the work of this Section for a fully operational, compliant with applicable codes and standards telecommunication cabling systems.

B. Voice Over Internet Protocol (VoIP): This section has been adapted to accommodate the Department's VoIP.

C. Related Sections include the following:

1. Section 270508 "Common Work Results for Telecommunications."
2. Section 270526 "Grounding and Bonding for Communications Systems."
3. Section 270553 "Identification for Communications Systems."
4. Section 271116 "Communications Cabinets and Frames."
5. Section 271543 "Communications Faceplates and Connectors."
6. Section 272129 "Data Communications Switches and Power Supplies."

1.2 STANDARDS

A. See Section 270508 "Common Work Results for Telecommunications" for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTAL

A. Product Data: Submit manufacturers' data for entrance protection: including but not limited to entrance protector panels, entrance protectors, and termination fields.

B. Shop Drawings: See Section 270508 "Common Work Results for Telecommunications."

C. Installer Qualifications Documents: See Section 270508 "Common Work Results for Telecommunications."

1.4 QUALITY ASSURANCE

A. Installer Qualifications: See Section 270508 "Common Work Results for Telecommunications."

B. Source Limitations: Obtain telecommunication cabling system such as cable, jack, termination blocks, patch panels, path cords etc. through one single manufacture. Match components and interconnection for optimum future performance.

C. Comply with the OBO Electrical Code; see Section 270508 "Common Work Results for Telecommunications."

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 "Common Work Results for Telecommunications."

1.6 PROJECT CONDITIONS

A. See Section 270508 "Common Work Results for Telecommunications."

1.7 COORDINATION

A. See Section 270508 "Common Work Results for Telecommunications."

1.8 EXTRA MATERIAL

A. Furnish extra materials identified below that match products installed. Package with protective covering for storage and identify with labels describing contents.

1. Patch-Panel Units: Two of each type for every 6 installed, but no less than 1.
2. Connecting Blocks: Two of each type for every 25 installed, but no less than 1.

PART 2 - PRODUCT

2.1 SYSTEM REQUIREMENT

A. General: Equipment and components shall not be intermixed between different manufactures.

B. Allowance for change and expansion:

1. Horizontal Distribution Expansion: Provide 25 percent minimum for termination devices in TR.

2.2 MOUNTING ELEMENT

A. Backboards: A-C grade, fire-retardant treated plywood, 19-mm thick, 2440mm high unless otherwise noted, capable of supporting attached equipment. Paint backboard in light color matching with other walls, except portions with stamps indicating fire rating on plywood; stamps shall remain visible at all times.

2.3 TERMINATION EQUIPMENT

A. Fiber Optic Patch Panel:

1. Provide fiber patch panels as indicated in Construction Drawings. Fiber patch panels shall be 2 RU minimum. 1RU fiber patch panel is not allowed unless approved by OBO/PDCS/DE/EE-Telecom.
2. Provide pullout splice trays within cabinets suitable to house required number of pigtail splices if required by termination method used. Each fiber optic interconnect center shall consist of sufficient number of splice trays and splices (if required), interconnection sleeves, and connectors to minimally terminate specified number of fiber strands.
3. Equip fiber termination panels to provide slack and fiber management.
4. Furnish fiber termination panels with fully populated pre-assembled non-angled multi-mode duplex LC style adapter plates.
5. Provide two rack unit of horizontal cable management for every two rack units of patch panel height.

B. Data Patch Panel for UTP (Copper) Cables:

1. Modular patch panels shall be either 24 or 48-port as indicated on Drawings. Each modular patch panel shall contain quantity of CAT6 8-position/8-conductor (RJ-45) connector. RJ-45 connectors shall be color coded to match with the CAT6 cables installed (i.e., orange, green, yellow, purple, and gray.)
2. Modular patch panels shall be 483mm rack mountable units.
3. Modular patch panels shall be used to terminate all OpenNet, SPARE/Tenant, CATV. SPARE 2 applies to CAA spaces only.
4. Provide dust covers for connectors to protect from dust and debris.
5. Provide two rack unit of horizontal cable management for every two rack units of patch panel height.

C. Voice, and WLAN Patch Panel for UTP (Copper) Cables:

1. Modular patch panels shall be either 24- or 48-port as indicated on the drawings. Each modular patch panel for voice horizontal cables shall contain the quantity of CAT6 8-position/8-conductor (RJ-45) connectors as required plus 25 percent spare. Terminate all 4-pairs using T568A wiring scheme. RJ-45 connectors shall be blue.
2. For intrabuilding and on-compound interbuilding voice backbone cabling, terminate one pair per port on pins 4&5. Patch panels for backbone cabling shall be 25-port RJ-45 patch panels. The only exception to this is for primary incoming service. A separate 110-style

termination field shall be installed adjacent to primary protection panels (for LSP copper-based service only) for cross-connects to LSP circuits in the CMPD TSEF.

3. WLAN networks shall have dedicated modular patch panels. Patch panel for WLAN shall be installed in voice cabinet. Connectors at patch panels shall be RJ45 CAT 6A, terminated WLAN cables using T568A wiring scheme. CAT6A connectors for WLAN shall be yellow.
4. Modular patch panels shall be 483mm rack mountable units.
5. Modular patch panels shall be used to terminate all Voice and WLAN cables.
6. Provide dust covers for connectors to protect from dust and debris.
7. Provide two rack unit of horizontal cable management for every two rack units of patch panel height. Provide one rack unit of cable management for every one unit of patch panel height.
8. Do not terminate cabling supporting CAA and non-CAA in the same termination field (patch panel). See separation requirements in the Drawings.
9. Install blanks between termination fields supporting CAA and non-CAA.
10. Voice termination fields shall not share cabinets with other systems.

D. Television Patch Panel for F/UTP (Copper) Cables:

1. Modular shielded patch panels shall be either 24 or 48-port as indicated on Drawings. Each modular shielded patch panel for horizontal shall contain quantity of CAT6a 8-position/8-conductor (RJ-45) connector. RJ-45 connector for CATV shall be purple.
2. Modular shielded patch panels shall be 483mm rack-mountable units.
3. Use modular shielded patch panels to terminate television and to provide spare capacity for future expansion.
4. Provide dust covers for connectors to protect from dust and debris.
5. Provide two rack unit of horizontal cable management for every two rack units of patch panel height.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Make terminations only at indicated outlets, frames, and cross-connect and patch panels.

B. Group connecting hardware for cables into separate logical fields.

3.2 INSTALLATION IN TELECOMMUNICATION EQUIPMENT SPACES

A. Patch Panels:

1. Use patch panels to terminate cables entering telecommunication equipment spaces (e.g., TRs), and additional locations shown on Construction Drawings, unless otherwise indicated.

2. Install patch panels within cabinets.

3.3 GROUNDING

A. Comply with Section 270526 “Grounding and Bonding for Communications Systems.”

END OF SECTION 271119

SECTION 271123 – COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cable management materials, equipment, and installation practices required for a fully operational, certified telecommunication cabling system compliant with all applicable codes and standards.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety” for supports and anchors.
2. Division 26 Section on raceways and boxes for pathways containing telecommunications cabling.
3. Division 26 Section on cable trays for pathways containing telecommunications cabling.
4. Division 26 Section on vibration and seismic controls for electrical systems.
5. Section 270508 “Common Work Results for Telecommunications.”
6. Section 270526 “Grounding and Bonding for Communications Systems.”
7. Section 271116 “Communications Cabinets and Frames.”
8. Section 271119 “Communications Termination Blocks and Patch Panels.”

1.2 STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508

1.3 SUBMITTAL

A. Product Data: Submit manufacturers’ data.

B. Shop drawings: Section 270508 “Common Work Results for Telecommunications.”

C. Qualifications Documents: See Section 270508 “Common Work Results for Telecommunications.”

1.4 QUALITY ASSURANCE

A. Contractor Qualifications: See Section 270508 "Common Work Results for Telecommunications."

B. Obtain cable management and ladder rack and all associated accessories through one single manufacturer.

C. Match components and interconnection for optimum future performance.

D. Comply with the OBO Electrical Code; see Section 270508 "Common Work Results for Telecommunications."

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 "Common Work Results for Telecommunications."

1.6 COORDINATION

A. See Section 270508 "Common Work Results for Telecommunications."

PART 2 - PRODUCT

2.1 CABLE MANAGEMENT AND LADDER RACKS

A. Basis of Design: Provide equipment and components from the following manufacturer or manufacturer approved by Project Director/COR:

1. Chatsworth

B. Ladder Racks:

1. Racks shall have maximum load with minimal deflection is 200 kg/m when supported every 1500 mm.
2. Construct of rectangular steel tubing.
3. Field constructed accessories such as transitions, splices, bends are prohibited.
4. Provide manufactured junction splices to join pieces of ladder rack.
5. Ladder rack assembly shall be UL listed.

C. D-Rings: Metal

1. Size: 50 mm minimum.
2. Corrosion-resistant and fire-resistant.

D. Cable Straps: Velcro; manufactured for specific use of bundling cable.

E. Cable tie mounting pads: Metal screw must be installed in each mounting pad. Pads installed utilizing only adhesive backing are not permitted. Exception: metal, glass, or granite surfaces. All other applications must receive prior approval from OBO/PDCS/DE/EE.

2.2 J-HOOKS

A. Provide equipment from the following manufacturer or manufacturer approved by the Project Director/COR:

1. ERICO Caddy Cable Cat Support System

B. Base: Wide.

C. Finish: Galvanized.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect pathway elements intended for cables. Verify raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with ANSI/TIA Standards 568 and 569.

B. Provide sufficient support for ladder racks and installed cables. Ladder racks shall extend in straight line from wall to wall, be supported at wall attachments, and at every 10 feet.

C. J-Hooks:

1. Use of J-hooks is limited to transitions from cable tray to conduit drops. J-hooks are not permitted in new construction of office buildings; any other application must be approved by Project Director/COR based upon input from OBO/PDCS/DE/EE.
2. Install at 1.22 meter or 1.52 meter interval.

D. D-rings: D-Rings may be used at backboards to route and cable inside telecommunications equipment spaces.

E. Bridle Rings: Use is not permitted.

F. Junctions:

1. Junctions for ladder rack shall be used to allow transitions in various directions.
2. Junctions for ladder rack shall be constructed of solid tubular steel.

G. Expansion Capacity:

1. Horizontal Distribution Expansion: Provide 25 percent minimum for pathways, number of outlets and termination devices in telecommunication equipment spaces.
2. Backbone Expansion: Provide 50 percent minimum of pathways.

H. Provide horizontal cable management and cable management covers above and below each copper and fiber patch panel and switches.

I. Provide horizontal cable management on back of each copper patch panel.

J. For equipment cabinets/enclosures, provide vertical cable management and cable management covers extending full height of rack, including both sides.

K. Radii and Bends:

1. Provide radii and bends for smooth cable transitions for turns and drops.
2. Radii and bends shall be constructed of the same material as the ladder rack.

L. Install cable ties loosely so that they do not damage or deform cable. Ties shall be able to spin around bundled cable.

M. Cables shall not be bundled with tape, rope, rubber bands, or similar fashion.

N. Cable Straps: Use in telecommunications equipment spaces for telecom from entry into room to cabinet or to termination point.

3.3 GROUNDING

A. Bond all ladder rack and other metallic hardware used for communication distribution to nearest grounding busbar. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware. Refer to Section 270526 “Grounding and Bonding for Communications Systems.”

END OF SECTION 271123

SECTION 271305 – COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes backbone cabling for fully operational telecommunication system.

B. Related Sections include the following:

1. Section 270508 “Common Work Results for Telecommunications.”
2. Section 270533 “Identification for Communications Systems.”
3. Section 271116 “Communications Cabinets and Frames.”
4. Section 271543 “Communications Faceplates and Connectors.”
5. Section 272129 “Data Communications Switches and Power Supplies.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s literature and sample of telecommunications installation materials.

B. Shop Drawings: See Section 270508 “Common Work Results for Telecommunications.”

C. Installer Qualification Document: See Section 270508 “Common Work Results for Telecommunications.”

1.4 QUALITY ASSURANCE

A. Installer Qualifications: See Section 270508 “Common Work Results for Telecommunications.”

B. Source limitations: Obtain telecommunication cabling system such as cable, jack, termination blocks, patch panels, and path cords through one single manufacturer. Match components and interconnection for optimum future performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 "Common Work Results for Telecommunications."

1.6 PROJECT CONDITIONS

A. See Section 270508 "Common Work Results for Telecommunications."

1.7 COORDINATION

A. See Section 270508 "Common Work Results for Telecommunications."

B. Coordinate with other trades for installation of backbone cabling such as mechanical, electrical, and structural.

PART 2 - PRODUCTS

2.1 GENERAL

A. All cables in this Section shall conform to TIA standards cited in Section 270508 "Common Work Results for Telecommunication."

2.2 OUTSIDE PLANT OPTICAL FIBER DISTRIBUTION CABLE

A. Fiber Construction:

1. Multimode: OM4 (50/125 micron laser-optimized) loose tube, fiber optic backbone cable shall be used for voice and data connectivity.
2. Single-Mode: OS2 (8.3/125 micron) loose tube, fiber optic backbone cable shall be used where required for voice and data connectivity.

B. Core shall consist of loose tubes around central dielectric strength member.

C. Cable shall contain water-blocking yarns wrapped with water swellable tapes.

D. Jacket shall be medium density PE jacket.

2.3 OUTSIDE PLANT COPPER DISTRIBUTION CABLE

A. Distribution cable for telephone system connectivity throughout campus shall be multi-pair OSP PE-39 or PE-89 unshielded twisted pair (UTP) within single sheath. See drawing riser diagram for required pair counts and category required for OSP UTP copper backbone.

B. Conductors: Solid 0.5 mm, annealed bare copper.

C. Insulation: Either solid polyolefin or foamed polyolefin with solid covering of polyolefin.

D. Fill cable core with waterproofing gel filled compound and wrap in non-hygroscopic core tape.

E. Shielding: Steel Aluminum black Polyethylene (STALPETH).

F. Cable Jacket: Black polyethylene with sequentially printed metal markers at regular intervals.

G. Air-filled cables are not permitted.

H. Cables shall comply with ANSI/ICEA S-80-576 for standard US color codes and binder color code integrity.

I. All cables shall be American Standard type.

2.4 INSIDE/OUTSIDE OPTICAL FIBER DISTRIBUTION CABLE

A. Cable shall be UL listed.

B. Cables shall be OFNx (optical fiber nonconductive riser or plenum) and comply with NFPA 262 and NFPA 70.

C. Fiber Construction:

1. Multimode: OM4 (50/125 micron laser-optimized) Interconnected tight buffered or loose tube, fiber optic backbone cable.
2. Single-Mode: OS2 (8.3/125 micron) Interconnected tight-buffered or loose tube, fiber optic backbone cable,

D. Core shall consist of tight buffered or loose tubes around central dielectric strength member.

E. Cable shall contain water-blocking yarns wrapped with water swellable tapes.

F. Jacket shall be flame-retardant and UV resistant.

2.5 INSIDE BUILDING OPTICAL FIBER DISTRIBUTION CABLE

A. Cable shall be UL listed.

B. Fiber Construction:

1. Multimode: Interconnected tight-buffered, OM4 laser optimized with core/cladding size of 50/125 microns.
2. Single-Mode: Interconnected tight-buffered, OS2 with core/cladding size of 8.3/125 microns.

C. Core shall consist of tight buffer around central dielectric strength member. Cable shall contain strength members to satisfy mechanical and environmental specifications provided herein.

D. All finished fibers shall be color coded by manufacturer for identification. Provide field terminations or spliced pigtails to terminate fibers.

E. Nominal insertion loss shall not be greater than 0.75 dB per mated pair for MM.

F. LC Mechanical Connectors:

1. Corning UniCam.
2. Commscope Pre-Radiused.
3. Other comparable manufacturer as approved by the Project Director/COR.

2.6 INSIDE BUILDING COPPER BACKBONE CABLE

A. Backbone Cable: Copper unshielded twisted pair, refer to riser diagram for pair counts and category required.

B. Backbone Cable for Data: Copper unshielded twisted pair, Category 5E minimum.

C. Cable shall be UL listed.

D. Conductors: 0.5 mm solid bare copper-paired thermoplastic insulated conductors, formed into binder groups of 25 pairs and assembled to form single compact cored covered by protective sheath.

E. Sheath: Underlying metallic shield, with one or more layers on dielectric materials applied over core.

F. Cable shall comply with NSI/ICEA S-80-576 color for standard US color codes and binder color code integrity.

2.7 COAXIAL BACKBONE CABLE

A. Coaxial cable elements shall have 75-ohms nominal impedance. Coaxial cable shall bear plenum- or riser-rated markings for environment in which they are installed.

B. CATV Indoor Trunk Cable: RG-11/U, cellular-polyethylene dielectric, bare-copper braid shield with 100 percent minimum shielding factor, 2.5 mm, solid bare-copper conductor.

C. CATV Outdoor Trunk Cable: Coaxial cable for incoming services; with concurrence of Project Director/COR based upon input from OBO/PDCS/DE/EE project telecom engineer, single-mode optic cable may be used instead.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment according to manufacturer’s directions, approved shop drawings, and referenced standards identified in this Section.

B. Install cables using techniques, practices, and methods that are consistent with rating of components, and that ensure performance of completed and linked signal paths, end-to-end.

C. Install cables without damaging conductors, shield, or jacket. Install all fiber backbone cables inside innerduct.

D. Do not bend cables, in handling or in installing, to smaller radius than minimums recommended by manufacturer’s installation recommendation.

1. Outside Plant Optical Fiber Distribution Cable: Minimum static or no load-bending radius for cable shall be no greater than 10 times the outside diameter of the cable.
2. Inside Optical Fiber Distribution Cable:

a. Minimum static or no-load bending radius shall be less than 10 times the outside diameter of the cable.
b. Minimum dynamic or loaded bending radius shall be less than 20 times the outside diameter of the cable.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Pull cables simultaneously if more than one is being installed in same raceway.

1. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation. Lubricant shall be viscous gel or colorless liquid with no odor. Use lubricants which deter rodents and insects.
2. Use pulling means, including fish tape, cable, rope, and basket weave wire or cable grips, which will not damage media or raceway.

3. Remove cable from pathways that has been damaged (tears in cable sheath) during installation. Replace damaged cable with new cable within same raceway.

F. Outside Plant Optical Fiber Distribution Cable Installation:

1. Connect fibers utilizing field-installed terminations or spliced pigtails.
2. Only fusion splicing is permitted.
3. WLAN networks shall share the voice/PBX fiber optic backbone.

G. Outside Plant Copper Distribution Cable Installation:

1. Configure cable groups in separate color-coded binder groups. Identify binder groups and individual pairs using industry standard color codes.
2. Do not splice cables.

H. Inside Building Optical Fiber Distribution Cable Installation:

1. Use either plenum- or riser-rated cabling as required by installation environment and model NFPA 70. Use plenum-rated cable within areas designated as air plenums.
2. Connect fibers utilizing field-terminated LC, or mechanical LC connectors.
3. WLAN networks shall share the voice/PBX fiber optic backbone.

I. Inside Building Copper Backbone Cabling Installation:

1. Do not splice cable.
2. Use either plenum- or riser-rated cabling, as required by installation environment and model NFPA 70. Use plenum-rated cable within areas designated as air plenums.
3. Copper riser cables shall only be installed within building. Outside plant (OSP copper cable is not permitted for use as riser cable.
4. Copper backbone cables for voice shall not connect CAA and non-CAA Telecom rooms. Route copper backbone so the cables enter each CAA floor at one location.

3.2 FIELD QUALITY CONTROL

A. Pre-Qualification Tests: Recommend contractor performs pre-qualification tests prior to Government acceptance testing.

B. Acceptance Testing: Government may procure services of independent test firm to perform acceptance testing of each section or infrastructure, and to inspect installation to ensure work has been performed in accordance with contract requirements.

1. Acceptance testing shall not begin until all work is completed. No construction which limits access or which produces adverse conditions that can adversely affect test result are permitted. For example, all finish work on floors walls and ceilings which produces dust shall be completed prior to testing. Contractor shall have completed all work on cable plant or in telecommunications spaces prior to acceptance.

2. Testing parameters are as follows:

   a. Copper cable plant will use Level IV tester for conformance with performance requirement of ANSI/TIA 568.2 for all category levels including CAT3 UTP cable. UTP copper backbone/riser cables testing will be for continuity, length, polarity, and wire map. Coax cables testing will be for continuity and length.
   b. Multimode Fiber optic cable plant testing will use instrumentation based on ANSI/TIA 526-14, Method B (one jumper method), for Multimode fiber cable testing, and ANSI/TIA 526-7 one jumper method for single mode cable. Testing will be bi-directional at both operating windows using power optical loss test equipment set such as Fluke DSX-5000. OTDR traces of fiber optic cables may be performed.
   c. Marginal test results (sometimes shown as PASS*) are not acceptable and are considered a failed test result.

3. Contractor shall be present during acceptance testing to replace/repair all work that fails.
4. Contractor is financially responsible for all costs associated with repair or replacement of cable, terminations, equipment, and other associated items which are identified as failing during acceptance testing.

END OF SECTION 271305

SECTION 271505 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes UTP, F/UTP cabling, fiber cabling, coaxial cabling, and terminating devices, required for a fully operational, telecommunication system conforming to referenced standards.

B. Related Sections include the following:

1. Division 07 Section on penetration firestopping for materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety” for supports and anchors.
3. Section 262725 “Wiring Devices” for devices installed in boxes and for floor-box service fittings.
4. Division 26 Section on raceways and boxes for electrical systems for pathways containing telecommunications cabling.
5. Division 26 Section on cable trays for pathways containing telecommunications cabling.
6. Section 270508 “Common Work Results for Telecommunications.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTAL

A. Product Data: Provide manufacturer’s literature and sample of telecommunications installation materials.

B. Shop Drawings: See Section 270508 “Common Work Results for Telecommunications.”

C. Qualification Documents: See Section 270508 “Common Work Results for Telecommunications.”

1.4 QUALITY ASSURANCE

A. Installer Qualifications: See Section 270508 "Common Work Results for Telecommunications."

B. Source limitations: Obtain telecommunication cabling system such as cable, jack, termination blocks, patch panels, and path cords through one single manufacturer. Match components and interconnection for optimum future performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 "Common Work Results for Telecommunications."

1.6 PROJECT CONDITIONS

A. See Section 270508 "Common Work Results for Telecommunications."

1.7 COORDINATION

A. See Section 270508 "Common Work Results for Telecommunications."

1.8 EXTRA MATERIAL

A. Furnish extra materials described below to the Project Director/COR that match products installed and are packaged with protective covering for storage and identified with labels describing contents:

1. Extra Materials:

a. Cable: 300 meters of each type used for Project. Furnish on separate reels for each type/color.
b. One complete set of termination tools for cabling types included in this Section. Furnish in single carrying case.

1.9 CONTRACTOR-FURNISHED GOVERNMENT-INSTALLED (CFGI) MATERIAL

A. Furnish the materials identified below as CFGI materials. Most of this material will be installed by the Government as part of the Project, though some of it (as determined by the Government and identified through the Project Director/COR) will be kept by the Government as extra material.

1. Patch Cords:

a. Electrical performance of LAN and voice patch cords shall equal electrical performance of cable used within system being patched interconnected, or cross-connected.
b. Fiber Patch Cords: OM4 conforming to cable transmission performance standards in ANSI/TIA/EIA 568.3; see Table 1.9, "Patch Cords."
c. Same manufacturer furnishing UTP and F/UTP jacks and cable shall furnish UTP and F/UTP patch cords.
d. Same manufacturer furnishing fiber optic connections shall furnish fiber optic patch cords.
e. Furnish in quantities for different types and colors as identified in Table 1.9, "Patch Cords." Furnish cords in separate boxes for each cord type/length/color. Patch cord quantities shall not be changed without prior written approval of OBO/PDCS/DE/EE.
f. Provide fiber patch cords for terminations between MTC and JUCR cabinets for each network (i.e., OpenNet, Spare, and Spare2) in the following quantity. Provide three (3) duplex patch cables for every 12 strands of fiber optic cable installed. Connectors shall be compatible with the termination at the panel(s). Provide patch cables for each type of fiber cable(s) installed (i.e., Singlemode and Multimode).

TABLE 1.9 – PATCH CORDS

LOCATION	LENGTH	TYPE [A B] UTP & F/UTP (copper)
TR	0.45 m (1-1/2 ft)	orange – 50% blue – 50% green – 25% yellow – 25% purple – 25% WLAN yellow CAT6A-50%
	1.0 m (3 ft)	orange – 50% blue – 50% green – 25% yellow – 25% purple – 25% WLAN yellow CAT6A- 50%
Work Area	2.0 m (7 ft)	orange – 50% blue – 50% green – 25% yellow – 25% purple – 50%
	3.0 m (10 ft)	orange – 50% blue – 50% green – 25% yellow – 25% purple – 50%
	5.0 m (15 ft)	WLAN yellow CAT6A- 100%
LOCATION	**LENGTH**	**[C D] FIBER**
TR	0.45 m (1-1/2 ft)	[E] 150%
	1.0 m (3 ft)	[E] 150%
Work Area	2.0 m (7 ft)	50%
	4.5 m (15ft)	[E] 50%

[A] TR UTP & F/UTP: Percent in relation to patch panel capacity.

[B] Work Area outlets (WAO) and wall phones UTP & F/UTP: Percent in relation to Work Area outlets and wall phones count.

[C] TR Fiber LC-to-LC OpenNet and Voice Patch Cords: Provide minimum two each of one-meter duplex length patch cords per client switches for both voice and data.

[D] TR Fiber LC-to-LC Patch Cords: Additionally, for each TR furnish 10 of this type of fiber patch cord at 1-m length.

[E] Fiber patch cable color shall match color of horizontal fiber. Refer to set B document for additional color code required for fiber. Percent in relation to Work Area outlet count.

1.10 ELECTRIC VEHICLE (EV) CHARGING STATION PATCH CABLES

A. Patch cables shall be CFCI, one (1) per charging station plus two (2) additional spares.

B. 100% of the patch cables shall be supplied by the Contractor.

C. Patch cables shall be CAT6 (or EV manufacturer recommended) and OSP-rated.

D. Patch cable length shall be long enough to connect between the EV charger and NEMA enclosure and will be site-specific to be determined by the Contractor.

PART 2 - PRODUCT

2.1 SYSTEM REQUIREMENT

A. General: Equipment and components shall not be intermixed between different manufactures.

B. Expansion Capacity:

1. Horizontal Distribution Expansion: Provide 25 percent minimum for pathways, number of outlets and termination devices in Telecommunications Room (TR) and other equipment rooms for telecom.

2.2 TELECOMMUNICATION CABLE

A. Fiber Optic Horizontal Distribution Cable: As indicated on Drawings.

1. Fiber optic station cables shall be rated OFNP (optical fiber nonconductive plenum) per installation environment as defined by model NFPA 70.
2. Fiber construction shall be tight-buffered multi-mode 850nm OM3 laser-optimized with core/cladding size of 50/125µm.
3. Fiber construction shall consist of two fibers in single jacket, duplex tight-buffered cables with outer jacket around full fiber jacket.
4. Maximum Cable Attenuation:

a. 850 nanometers: 3.0 dB/km.
b. 1300 nanometers: 1.5 dB/km.

5. Minimum overfilled modal bandwidth-length product:

   a. 850 nanometers: 1500 MHz-km.
   b. 1300 nanometers: 500 MHz-km.

6. Refer to IFC drawings and/or J.3.5 document for color code of fiber jacket. Terminate fibers utilizing field-installed LC connectors or spliced pigtails. Nominal connector loss using either termination method shall not be greater than 0.75 dB per mated pair.
7. Fiber cable shall be able to withstand maximum tensile load of 220 N (50 lbf) during construction.

B. UTP Horizontal Distribution Cable for Voice, OpenNet, Spares, and WLAN.

1. Horizontal distribution cables for voice, OpenNet, and spares shall be UL Listed cable that meets or exceeds ANSI/TIA Standard 568.2 Category 6 specification for performance at 250 MHz.
2. Horizontal distribution cables for WLAN shall be two CAT6A UL Listed cable that meets or exceeds ANSI/TIA Standard 568.2.
3. Where required, horizontal cable shall be marked CMP for use within inside building return air plenum as defined by model NFPA 70. For CMP (plenum type) cable, all 4-cable pairs shall be insulated with FEP.
4. Cables shall be distinguished by different color sheaths for each purpose. Voice (telephone) cable shall be blue. OpenNet cable shall be orange. Spare 1 cables shall be green. WLAN cables shall be yellow CAT 6A outside the CAA.
5. Cables shall be distinguished by different color sheaths for each purpose. Voice (telephone) cable shall be blue. OpenNet cable shall be orange. Spare 1 cables shall be green. Inside CAA, Spare 2 cables shall be yellow Cat 6.

C. F/UTP Horizontal Distribution Cable for Television:

1. Horizontal distribution cables for television shall be UL Listed cable that meets or exceeds ANSI/TIA Standard 568.2 CAT 6A specification for performance at 250 MHz.
2. Where required, horizontal cable shall be marked CMP for use within inside building return air plenum as defined by model NFPA 70. For CMP (plenum type) cable, all 4-cable pairs shall be insulated with FEP.
3. F/UTP cables shall be purple.

2.3 COAXIAL TRANSMISSION COMPONENTS

A. Cable: Coaxial cable elements have 75-ohms nominal impedance. Coaxial cable shall bear plenum or riser rated markings for environment in which they are installed.

1. CATV Indoor Branch Cable: RG-6/U quad-shielded, cellular-polyethylene dielectric, bare-copper braid shield with 100 percent minimum shielding factor, 1.0 mm^2 solid copper-clad-steel conductor.

B. Coaxial Connector: Type F, 75-Ohms, unless otherwise noticed.

C. Signal Strength: Frequency range is 5 MHz to 1 GHz.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Installation Standards: ANSI/TIA 568 and 569, all sections and annex.

B. Wiring Method: Install wiring and optical fiber in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

C. Install cables using techniques, practices, and methods that are consistent with Category 6 and 6A rating of components and that ensure Category 6 and 6A performance of completed and linked signal paths, end to end.

D. Install cables without damaging conductors, shield, or jacket.

E. Do not bend cables, in handling or in installing, to smaller radius than minimums recommended by manufacturer’s installation recommendation.

1. Fiber Optic Horizontal Distribution Cable: Minimum static or no-load bending radius for cable shall be no greater than 10 times outside diameter of cable. Minimum dynamic or loaded bending radius shall be no greater than 20 times outside diameter of cable.

F. Service Loop: Provide 300 mm-service loop in workstation outlet box or above ceiling at workstation location.

G. Cable Pulling: Pull cables without exceeding cable manufacturer's recommended pulling tensions. Pull cables simultaneously if more than one is being installed in same raceway.

1. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation. Lubricant shall be viscous gel or colorless liquid with no odor. Use lubricants, which deter rodents and insects.
2. Use pulling means such as fish tape, cable, rope, and basket weave wire or cable grips that will not damage media or raceway.
3. Cable that has been damaged (tears in cable sheath) during installation shall be removed from pathways. Replace damaged cable with new cable within same raceway.

H. Install exposed cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

I. Secure and support cables at intervals not exceeding 760 mm and not more than 150 mm from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

J. Wiring within Telecommunications Equipment Spaces: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radius than minimums recommended by manufacturer.

K. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels. Cables shall be homerun to TRs and other equipment rooms for telecom; midspan splices are not permitted.

1. UTP and F/UTP Horizontal Distribution Cable for Voice, OpenNet, Spares, WLAN, and Television: Cable shall be home run to TRs and other equipment rooms for telecom; splices are not permitted.

3.3 IDENTIFICATION

A. Comply with applicable requirements in Section 270553 "Identification for Communications Systems" and ANSI/TIA Standard 606.

3.4 FIELD QUALITY CONTROL

A. Pre-Qualification Tests: Recommend contractor performs pre-qualification tests prior to Government acceptance testing.

B. Acceptance testing shall not begin until all work is completed. No construction which limits access, or which produces adverse conditions that can adversely affect test result are permitted. For example, all finish work on floors walls and ceilings which produces dust shall be completed prior to testing. Contractor shall have completed all work on cable plant or in telecommunications spaces prior to acceptance.

C. Testing: The Government may procure services of independent test firm to perform acceptance testing of each section of infrastructure and inspect installation to ensure work has been performed in accordance with contract requirements.

D. Contractor shall be present during acceptance testing to replace/repair all work that fails.

E. Testing parameters are as follows:

1. Copper cable plant will use Level IV tester for conformance with performance requirement of ANSI/TIA 568.2 for all category levels including CAT3 UTP cable. UTP copper backbone/riser cables testing will be for continuity, length, polarity, and wire map. Coax cables testing will be for continuity and length.
2. Multimode Fiber optic cable plant testing will use instrumentation based on ANSI/TIA 526-14, Method B (one jumper method), for Multimode fiber cable testing, and ANSI/TIA 526-7, one jumper method for single mode cable. Testing will be bi-directional at both operating windows using power optical loss test equipment set such as Fluke DSX-5000. OTDR traces of fiber optic cables may be performed.
3. Marginal test results (sometimes shown as PASS*) are not acceptable and are considered failed test result.

END OF SECTION 271505

SECTION 271543 – COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered under this section consists of faceplates and connectors for telecommunications cabling systems.

B. Related Sections include the following:

1. Division 07 Section on penetration firestopping.
2. Division 26 Section on raceways and boxes.
3. Section 270508 “Common Work Results for Telecommunications.”
4. Section 270553 “Identification for Communications Systems.”
5. Section 271119 “Communications Termination Blocks and Patch Panels.”
6. Section 271305 “Communications Backbone Cabling.”
7. Section 271505 “Communications Horizontal Cabling.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTALS

A. Product Data: Provide manufacture’s product literature of faceplates and connectors.

B. Qualification Documents: See Section 270508 “Common Work Results for Telecommunications.”

1.4 QUALITY ASSURANCE

A. Installer Qualifications: See Section 270508 “Common Work Results for Telecommunications.”

B. Comply with the OBO Electrical Code; see Section 270508 “Common Work Results for Telecommunications.”

C. Obtain faceplates and connectors from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 “Common Work Results for Telecommunications.”

1.6 COORDINATION

A. See Section 270508 “Common Work Results for Telecommunications.”

1. In addition, coordinate locations of outlets power, and other utilities.

1.7 EXTRA MATERIAL

A. Furnish extra materials described below that match products installed. Package with protective covering for storage and identify with labels describing contents.

1. Outlet Assemblies: ten (10) percent of each type installed, but no less than one (1).

PART 2 - PRODUCT

2.1 GENERAL

A. Install dust covers to prevent dirt/debris from entering ports, modular jacks, adapters, and connectors.

2.2 FACEPLATES

A. Manufacturers: Provide faceplates by manufacturer approved by Project Director/COR.

B. Color and Finish Coordination: Provide telecommunication manufacturer’s standard faceplates. Selection of standard color shall be coordinated with architectural design and finishes specified by the A/E in consultation with the OBO Project Team interior designer.

C. Mounting Configurations:

1. Equip faceplates with screw holes with screw retention tabs spaced for single gang openings.

a. Each faceplate shall be supplied with minimum 25-mm (1-inch) long screws.

2. Building Interior Telephone Outlet: Wall-mounted assembly for wall-mounted telephone sets.

    a. Acceptable Products: Commscope 76100891/M10LW4SP, along with associated RJ45 CAT 6 jack or equivalent.

3. Building Exterior Telephone Outlet: Wall-mounted assembly.

D. Floor-mounted access box shall conform to the following:

1. Provision boxes as indicated on Construction Drawings.
2. Size floor box to maintain adequate working space within box.
3. Provide outlets as indicated on Construction Drawings. Connector colors shall be as follows:

    a. Modular jack connectors for voice (VoIP) shall be blue.
    b. Modular jack connectors for data (ULAN/OpenNet) shall be orange.
    c. Modular jack connectors for SPARE 1 shall be green.
    d. Modular jack connectors for SPARE 2/WLAN shall be yellow.
    e. Modular jack connectors for CATV shall be purple.
    f. Modular jack connectors for AV shall be gray.

E. Wireless Access Point (WAP) Terminations shall conform to the following:

1. WAPs shall be mounted below ceilings or on walls. Outlets for ceiling mounted WAPs may be located above the ceiling.
2. Mounts for WAPs mounted on the ceiling grid are contractor furnished government installed (CFGI).
3. WAPs shall be mounted at a maximum height of 3-m (10-feet) above the finished floor.
4. Restrictions near CAA spaces.

    a. WAPs shall not mount to or be constructed within CAA walls, floors, and ceilings. CAA boundaries will not be physically impacted by wireless design and installation effort,

2.3 CONNECTORS

A. Manufacturers: Provide connectors from manufacturer approved by the Project Director/COR in coordination with OBO/PDCS/DE/EE.

B. Copper Connectors:

1. Telephone Jack: Wall-mounted assemblies consisting of RJ-45 modular jack with 8-positions/8-conductors IDC utilize T568A wiring scheme for voice.
2. Modular Jacks: Jacks shall utilize T568A wiring and shall conform to ANSI/TIA Standard 568.2 CAT6 specifications for performance.

3. WLAN Jacks: 8-position/8-conductor for use in WLAN outlets or at modular patch panels in TR to terminate UTP CAT 6A cables.
4. IP Television Jacks: Shielded 8-position/8-conductors for use in wall plate outlets or at modular patch panels in TRs to terminate F/UTP CAT 6A cables.
5. Connector Colors:

    a. See paragraph 2.2.D.3 above for voice, data, spare1, and spare 2 requirements.
    b. Modular shielded jack connectors for television shall be purple.
    c. Modular shielded jack connectors for AV shall be gray.

C. Fiber Optic Connectors:

1. Fiber optic connectors shall be 568 LC type connectors. Connectors shall have an insertion loss of not greater than 0.75 dB per mated pair of connectors. Connector shall enclose outermost coating of single fiber strand and have capability of being mated or unmated without using any tool. Connector shall be field installable.
2. Fiber optic connector shall be rated by manufacturer to withstand at least 1,000 couplings with variance in insertion loss with plus or minus 0.75dB.
3. Provide white duplex LC style adapter insert (also referred to as 568 LC in ANSI/TIA Standard 568.3) at faceplate when indicated on drawings.
4. Mechanical type terminations such as Corning UniCam and Commscope Pre-Radiused are permitted.
5. Pigtail splice-type terminations are permitted, to include mass fusion spliced connectors.
6. Provide associated accessories, tools, and installation kits.

    a. Required modules/adapters; white for patch panel/outlet placement.
    b. Housing panels for termination cabinet placement.

D. Coaxial Connectors:

1. Type F, 75 Ohm unless stated otherwise.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, proper grounding/bonding techniques, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected and shop drawings have been approved.

3.2 INSTALLATION

A. Install faceplates and connectors in accordance with referenced standards and manufacturer's recommendations.

B. Attach wall-mounted boxes to studs or to other support accessories or support.

C. Wall-Mounted Phones:

1. Building Interior: Install in single-gang electrical box.
2. Building Exterior:

a. Install 1200 mm (48 inches) above adjacent surface in flush-mount single-gang metal electrical box.
b. Provide one 4-pair UTP category 6 cable with 1 m (3 ft) pigtail. Terminate pigtail with category 6 RJ-45 jack for testing.
c. Weatherproof Telephone Enclosure: Provide Viking VE-9x12B-1P or equivalent, along with all necessary associated accessories.

END OF SECTION 271543

SECTION 272129 – DATA COMMUNICATION SWITCHES AND POWER SUPPLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes materials but not limited to data communication switches, wires, and connecting devices in Telecommunications Rooms (TRs) and other telecommunications equipment spaces, and other incidental components to support a fully operational telecommunications and data network system.

B. OpenNet Backbone (Core) Switches: These switches will be furnished and installed by the Government (GFGI) in the Joint Unclassified Computer Room (JUCR), other Unclassified Computer Room (UCR), or in DOS designated server rooms.

C. Related Sections include the following:

1. **[Division 26 Section on cable trays for pathways containing telecommunications cabling.]**
2. Section 263354 “Uninterruptible Power Supply (UPS) for Telecommunications.”
3. Section 270508 “Common Work Result for Telecommunications.”
4. Section 270526 “Grounding and Bonding for Communications Systems” for grounding bus bars and ground conductors.
5. Section 270553 “Identification for Communications Systems.”
6. Section 271116 “Communications Cabinets and Frames” for cabinets.
7. Section 271505 "Communications Horizontal Cabling" for patch cords.

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 SUBMITTAL

A. Product Data: Manufacturer’s literature and product data sheet.

B. Shop Drawings: See Section 270508 “Common Work Results for Telecommunications.”

C. Qualification Documents: See Section 270508 "Common Work Results for Telecommunications."

D. Certification of Source: Documentation as required in the Part 1 Article on QUALITY ASSURANCE.

E. Product List: Documentation as required in the Part 3 Article on FIELD QUALITY ASSURANCE.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: See Section 270508 "Common Work Results for Telecommunications."

B. Comply with the OBO Electrical Code; see Section 270508 "Common Work Results for Telecommunications.

C. Substantiation of Product Source:

1. Provide exact match to products specified in this section.
2. Products shall be brand new, not gray market, and shall be in original packaging.
3. Provide products through Cisco authorized channels for new federal sales. Vendor shall have certification and specialization level required by Cisco to support product sale and product pricing in accordance with applicable Cisco certification and specialization requirements.
4. Certification of Source: Contractor shall require that the vendor confirm that it sourced all Cisco products from the manufacturer or through manufacturer authorized channels only, in accordance with applicable laws and policies at the time of purchase.

    a. The Department of State shall be listed as the owner/licensee of each product.

5. Third Party Components:

    a. Third party non-Cisco warranted products, used equipment, or "like new" equipment are prohibited.
    b. The government will perform random quality assurance to verify that third party components are not being incorporated.
    c. If it is determined that third-party components are used and warranties compromised, the contractor shall assume all cost to replace the items at no additional cost to the government.
    d. Infractions will be recorded in the contractor's performance evaluation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 270508 "Common Work Results for Telecommunications."

1.6 PROJECT CONDITIONS

A. See Section 270508 "Common Work Results for Telecommunications."

1.7 COORDINATION

A. See Section 270508 "Common Work Results for Telecommunications" for additional coordination.

1.8 WARRANTY

A. Provide full Cisco warranties. Do not provide products that adversely affect warranties of associated system and components.

1. Provide five years warranty from date of Substantial Completion for each rack mounted UPS.

1.9 EXTRA MATERIAL

A. Furnish extra materials described below that match products installed, that are packaged with protective covering for storage and are identified with labels describing contents. Deliver extra materials to the Project Director/COR.

1. OpenNet Switches: For less than 400 connections, provide one client switch. For 400 or more connections, provide two client switches.
2. Media Converters: For installations with 10 or less EV charging stations, provide 2 spare media converters. For installations with 10 or more, provide 2 spares for each additional 10 charging stations.

PART 2 - PRODUCT

2.1 ACCEPTABLE PRODUCTS

A. Products that may be incorporated into the work are identified below. Unless noted otherwise, products are from Cisco Systems, Inc. No substitutions to listed products are permitted.

2.2 UNCLASSIFIED NETWORK SWITCHES

A. General:

1. Furnish Cisco Smart Licensing for all switches.

a. Direct Smart License Keys purchased to:

1) Smart Account: ea-002.cisco.com
2) Virtual Account: OBO GC-AE

2. Provide fiber backbone so that the government may link each client switch directly to core switch. Size client switches to accommodate all OpenNet outlets indicated on floor plan plus 30 percent spare ports for future growth.
3. Provide appropriate patch cords for each port of client switches and other additional hardware/IOS firmware as required by manufacturer for gigabit connectivity.

B. OpenNet Client Switches:

1. Catalyst C9200L-48T-4X-A++=

a. TAA Compliant.
b. C9200L-NW-A-48
c. CAB-TA-NA
d. PWR-C5-BLANK
e. C9200-STACK-BLANK
f. C9200-DNA-A-48
g. C9200-DNA-A-48-5Y
h. PI-LFAS-T
i. PI-LFAS-AP-5Y
j. NETWORK-PNP-LIC

2. Catalyst C9200L-24T-4X-A++=

a. TAA Compliant.
b. C9200L-NW-A-24
c. CAB-TA-NA
d. PWR-C5-BLANK
e. C9200-STACK-BLANK
f. C9200-DNA-A-24
g. C9200-DNA-24-5Y
h. PI-LFAS-T
i. PI-LFAS-AP-5Y
j. NETWORK-PNP-LIC

C. Connector Fiber Module:

1. TAA Compliant.
2. SFP/SFP+ shall be OEM from the network switch manufacturer.
3. Coordinate appropriate SFP module with network switch manufacturer.
4. Provide one SFP with each fiber module.
5. Quantity: Two per switch.

2.3 RACK-MOUNTED COMMUNICATIONS UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Install rack-mounted communication UPS in every contractor-furnished telecom cabinet; see Section 271116 “Communications Cabinets and Frames” and Section 263354 “Uninterruptible Power Supply (UPS) for Telecommunications.”

2.4 ELECTRIC VEHICLE (EV) CHARGING STATION MEDIA CONVERTERS

A. Media Converters are required for each EV charger, one in the MTC/JUCR and one in the NEMA enclosure.

1. Basis of Design:

a. Transition Networks 100BASE-TX to 100BASE-FX

2. LC connectors
3. Provide a shelf in the MTC/JUCR cabinet for the media converters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with referenced standards and manufacturer’s instructions.

B. Handle assemblies and components with care.

3.2 FIELD QUALITY CONTROL

A. Product List: Prior to installation of any equipment, contractor shall submit medium access control (MAC) addresses and serial numbers of all acquired Cisco products.

END OF SECTION 272129

SECTION 274100 – AUDIOVISUAL SYSTEMS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general requirements for audiovisual (A/V) systems.

1. General systems components such as wire, cable, and racks.
2. Overall coordination of A/V system work and commissioning.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
2. Section 260525 “Grounding and Bonding for Electrical Systems.”
3. Section 262725 “Wiring Devices.”
4. Section 270508 “Common Work Results for Telecommunications.”
5. Section 270526 “Grounding and Bonding for Communications Systems.”
6. Section 270553 “Identification for Communications Systems.”
7. Section 270645 “Schedules for Audiovisual Systems” for location of A/V equipment and systems within various spaces.
8. Section 271305 “Communications Backbone Cabling.”
9. Section 271505 “Communications Horizontal Cabling."
10. Section 274114 “Architecturally-Integrated Audiovisual Elements.”
11. Section 274117 “Projection Screens and Projector Lifts.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications and A/V reference standards.

1. Each Division 27 Section may include citations to these references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

B. American National Standards Institute/ InfoComm International (AVIXA)(ANSI/INFOCOMM): Based upon the date of the design.

1. ANSI/AVIXA: A102.1:2022 "Measurement and Classification of Audio Coverage Uniformity in Listener Areas"
2. ANSI/AVIXA: D104.01:2023 "Documentation Requirements for Audiovisual Systems"
3. ANSI/INFOCOMM: 10:2013 "Audiovisual Systems Performance Verification"

C. International Electrotechnical Commission (IEC):

1. IEC 60268-16: Objective rating of speech intelligibility by speech transmission index.

1.3 PERFORMANCE REQUIREMENTS AND SYSTEMS DESCRIPTION

A. The work detailed within the Construction Documents is intended to meet certain requirements for performance and appearance. It is the responsibility of the Contractor to complete a translation of those requirements into a systems package containing all required parts, cable, software, and equipment to produce fully operational and operationally and functionally integrated audiovisual systems.

1. Any item not specifically shown on drawings or called out in the specifications but is required to produce the operational system and conform to the intent of A/V system is required to be included as part of the Work.
2. All equipment or systems are to be contractor furnished and contractor installed unless noted in the specification, drawing package, or other documents.

B. Optical Standards:

1. Total, average light output from projector (in lumens) shall be within plus or minus 15 percent of that specified by projector manufacturer.
2. Light fall-off from center of projected image to all four corners, as measured at projected image plane, shall not exceed 35 percent. Validation will be based on measuring light intensity at five positions of projected image after projector has been adjusted to provide light output as specified above. Light meter used for above measurements shall be properly calibrated lux (foot-candle) meter. It shall also be cosine corrected.

a. The “corner” location is defined as four points determined by intersecting lines drawn 5 percent of distance in from focused edges of image.

C. Control System User-Interface: Design control system user-interfaces pages for this project exclusively. The following are minimum requirements:

1. All panels shall have time and date as icons in same position on every page.
2. All panels shall have a title, indicating piece of equipment and/or functionality being controlled.
3. User interface design shall maintain continuity throughout compound to greatest extent practicable. The design shall take into account variations in system functionality from room type to room type.
4. Whenever the same button appears on more than one page, it shall be in the same position on each page.
5. Functions used during general presentation shall be accessible with minimal amount of button presses/page flips.
6. Implement multi-level access to controls.

7. There shall be a technical support page that shows the status of all devices connected to the control system.
8. The status shall be represented in a green or red light (button) format for quick trouble shooting.
9. Green represents that the device is online and active, communicating with the control system.
10. Red represents that the device is offline or is not communicating with the control system.

D. System Power: Provide power from rack-mounted uninterruptible power supply (UPS) for all programmed, software-based, or microprocessor-based control devices capable of providing 15 minutes minimum backup for those devices.

E. Electrical Characteristics: A/V equipment shall operate on 120 to 240 VAC at 50/60 Hz as appropriate to the host country.

1. Coordinate building NEMA receptacle types, 120 VAC (NEMA 5-20R) or 240 VAC (NEMA 6-20R) at 50/60 Hz as appropriate to the host country.

F. Operable Environmental Range: A/V equipment shall be capable of operating continuously for twelve hours over external ambient temperature range of 0 to 43 deg C (32 to 109 deg F), and 20 to 95 percent relative humidity without permanent damage or condensation.

1.4 SUBMITTALS

A. General: Technical submittals (e.g., product data, shop drawings, schedules) associated with all Division 27 A/V Specifications shall be submitted together with the submittals for this Section to facilitate coordination of systems.

B. The submittal package shall include all documents which support the A/V design and installation, at the minimum but not limited to the following:

1. Control system pages and flow diagram
2. Drawings – build to details
3. IP Information Sheet (which is a living document)
4. Data product sheets
5. Room and Equipment detail sheets
6. Cable Runs sheets
7. Finish Schedules for furniture:

C. The submittals shall be submitted in PDF.

1. The PDF documents shall be searchable.
2. The PDF documents shall utilize bookmarks for all major sections and details within the sections to facilitate quick switching between rooms and or other areas within the document.
3. Index listing all rooms in the project.

4. The first page of each manufacturer's PDF shall be bookmarked.

D. Within the manufacturer's PDF, the equipment relative to the project shall be highlighted or emphasized in a manner for quick reference.

1. Excessive pages from manufactures with no relation to project should be removed to reduce the size of the PDF document.

E. Control system pages and flow diagrams:

1. A/V contractor shall supply a page-by-page GUI submittal for review. The submittal must include a breakout showing each control panel page/sub-page and includes a list of all selectable buttons on that page and their function.

F. Shop Drawings: Submit the following A/V shop drawings and details as a separate package from any other submittal.

1. Detailed plan views and elevations of relevant telecommunications rooms and spaces that show raceway, sleeves, cable tray, cable paths, equipment racks, equipment cabinets, termination blocks, power receptacles, and grounding bus bars associated with A/V system.

G. Detailed drawings shall include all areas that will receive any A/V solution. The drawing set shall include at a minimum the following for each area:

1. An enlarged plan view for the facility requirements.
2. An enlarged plan view for the infrastructure requirements:

   a. A/V network drops
   b. A/V back boxes
   c. A/V conduit sizes and locations
   d. Wall boxes or screw cover (SC) boxes for racks or credenzas
   e. Cable tray and pathways
   f. Equipment rack locations for A/V and any other rack to support Telecommunications or other signals.
   g. Electrical connections locations
   h. Grounding bar connection locations

3. Elevation drawings for each A/V solution including but not limited to:

   a. Displays
   b. Wall mounted back boxes for displays
   c. In-Wall backing for displays
   d. A/V network drops "**"AFF
   e. Wall boxes or screw cover (SC) boxes for racks or credenzas "**"AFF
   f. Touch panels "**"AFF
   g. A/V conduit sizes and locations
   h. Any other devices locations "**"AFF

4. Consistent with Construction Drawings, detail installation of equipment and cable layout to further enhance operational efficiency and overall aesthetic factors.

    a. System-riser diagrams for each area with A/V components.
    b. System flow drawings with detailed wiring diagram input/output connections for each piece of equipment, interconnects, data flow, and other pertinent information.
    c. Wiring diagrams for each A/V subsystem that define interconnection of all inputs and outputs for all equipment.
    d. Power connection drawing for rack main power, UPS, rack power strips, power distribution units (PDU), equipment power connections.
    e. Grounding for racks
    f. Fabrication shop drawings for all custom equipment, as applicable.
    g. Plans and elevations of A/V equipment racks (including credenzas, consoles, desks and lecterns), quantifying all equipment to be mounted in each. The credenza, consoles, lecterns and A/V desks are supplied by the A/V contractor and coordinated with the interiors design team. If an A/V device is to be installed in a table or other furniture supplied by another source, the details shall be provided and noted as supplied by other (Company).

5. IP equipment information sheet with the following:

    a. Equipment manufacturer
    b. Model of the equipment
    c. A/V system Identifier
    d. Location of equipment
    e. Mac address
    f. IP address
    g. Wall plate connection number if applicable
    h. Patch panel number
    i. Network switch number
    j. Network switch port number

6. Product Data:

    a. Manufacturer’s product data sheets for all materials and equipment, sorted by room and indexed. Include available standard finishes for wall plates and floor boxes for selection by Project Director/COR. Mark each product data sheet to show applicable choices and options.
    b. Manufacturer's product data sheets for all associated fire-stopping materials.
    c. Manufacturer’s product data sheets for accessories, including technical panels, equipment racks, floor boxes and connection plates, escutcheons and trim components. Include fasteners and supports.

7. Room/Equipment detail sheet shall be broken out by equipment type sections in excel, each room should be on a separate tab within the excel workbook and printed out as such. The Room/Equipment detail sheet should be broken out as following per room:

a. Control
b. Display
c. Video
d. Audio
e. Collaboration
f. Racks, furniture, and other equipment

8. Cable run sheets (e.g., diagrams or spreadsheets) that denote cable type, signal type, termination type, cable number designation, start point, and end point.
9. Schedules:

a. List of finishes and sample graphics, including custom artwork and custom graphics per device, if applicable.

H. Spare Parts List: List of parts inventory to reflect manufacturer recommended service and maintenance of the work.

I. Qualifications:

1. A/V Installer Qualifications:

a. The installer firm shall have at least one out of four “Key People” on supervisory team which possess a CTS-D certification, from AVIXA or another recognized organization or institution providing formal training in audiovisual engineering and/or installation.
b. All employees of the contractor to install this system must be competent technicians who are experienced in the installation and interconnection of equipment in professional A/V environments and typical audiovisual systems.
c. All A/V engineering and project management is to be handled by a qualified, employee of the A/V contractor.
d. Key Personnel shall be identified as:

1) The Senior Project Manager
2) The Senior Engineer
3) The Senior Network Engineer
4) The Senior or Lead Tech

e. Resumes of the key personnel must be submitted with each submittal, replacement of the key personal must be submitted in writing to the COR along with the justification for the replacement. No outsourcing or sub-contracting of these tasks will be accepted.
f. Installer shall maintain an adequately equipped and staffed service department and shall regularly provide service for systems similar to this design. This shall include an office staffed with personnel at normal business hours, Monday through Friday, between the hours of 0800 and 1700. Answering services, cellular telephones, and call forwarding systems are helpful but do not meet nor comply with the intent of this specification.

g. The design will incorporate various types of A/V equipment, which includes displays, video distribution, processing and switching equipment; network design implementation, audio distribution and processing equipment; power amplifiers, speakers, etc.
h. Installer shall be currently authorized by the manufacturer of the major components of the system to sell their products and initiate warranty service on the same items.
i. Proof of certification and training on the products from the manufacturer is required. If a certification is not available, the proof of franchise shall be provided. This may be in the form of a letter from the appropriate manufacturer addressed to the COR stating that the contractor is currently authorized to sell their products. Letters from the sales representative (rep) shall not be accepted as proof.

J. Preconstruction Plan: Plan by qualified A/V subcontractor, no later than start of installation of infrastructure for A/V systems, for implementation that includes phased scheduling, staffing plan, and schedule for phased, testing, training, and project acceptance. In Plan, identify period of time during which this Onsite Factory-Trained Engineer will be onsite.

K. Field Quality Control Reports: Include field quality control reports and test results related to work of all A/V Specification Sections.

L. Factory Onsite Testing:

1. The A/V contractor shall provide Factory Onsite Testing (FAT) at their integration location.
2. The testing shall include operational system testing as the system will be installed.

a. The rack or credenza shall be built and tested; all testing shall be running off of these systems.
b. The display for each system or a typical representation for any video wall applications.
c. The control pages shall be active and loaded on the panel, if applicable.
d. Audio systems shall be represented in a manner which shows the functionality the DSP and other audio devices.

M. Pretesting Certification: Submit certification that audio signal lines have been pretested and verified. Include results in spreadsheet format.

N. Operations and Maintenance Manuals: Manuals shall apply to all A/V-related devices, equipment and software modules. Include, at a minimum, the following:

1. General:

a. Operational description of each subsystem.
b. Detailed programming descriptions for each subsystem.
c. Explanations of subsystem inter-relationships.
d. Electrical schematics for each piece of equipment specified.
e. Power-up and power-down procedures for each subsystem.

f. Description of all diagnostic procedures.
g. Menu tree for each subsystem.
h. Setup procedures for each component of the subsystems.
i. List of manufacturers, and their local representatives and subcontractors that have performed work on project.
j. Installation and service manuals for each piece of equipment.
k. Manufacturer's maintenance schedules for all installed components.
l. From Pretesting process in Article on FIELD QUALITY CONTROL, record normal settings for level controls.
m. Testing reports for all cables within the system.

O. Record Drawings:

1. Produce record files as required for the A/V systems.

a. Control system pages and flow diagram.
b. Drawings – as built with cable numbers and other identification information.
c. IP Information Sheet (which is a living document).
d. Data product sheets for any new equipment which were not part of the original submittal.
e. Room and Equipment detail sheets updated with any changes.
f. Cable Runs sheets.
g. Finish Schedules for furniture.
h. Spare parts list.

2. Provide all software control, user panels in an open and unlocked format and including both compiled and uncompiled versions.
3. Provide all configuration files for any equipment which had to be configured.

1.5 QUALITY ASSURANCE

A. Work specified for all A/V systems in this project shall be responsibility of single A/V systems contractor.

B. Single Source: Any given item of A/V equipment shall be the product of one manufacturer throughout the Project; multiple manufacturers of any one item is not permitted unless specifically noted otherwise.

C. Basis of Design: Within the A/V specifications, certain manufacturers and models have been listed. These manufacturers are listed for example purposes, unless followed by the term "no exceptions." Contractor may provide other manufacturers and models which meet or exceed specified functional, technical, and service support requirements.

D. On-site Factory-Trained Engineer: As part of installation and configuration activities, provide an onsite factory-trained engineer for the Digital Sound Processor (DSP) and A/V control products included in this project to facilitate coordination of performance of the systems for major spaces

such as Multi-Purpose Room, Gallery/Atrium, Large Conference Rooms, and Training Rooms. The Engineer shall be on-site for approximately one week at an optimum time as mutually determined by the Engineer and the Contractor based upon the status of the Work.

E. Provide CTS personnel assigned to project with CTS-D, certificate or equal NICET designation, with minimum of five years of industry experience.

1. If Contractor does not have certified engineers trained on a specified product, they must employ qualified engineer prior to preconstruction submission date and submit applicable certifications and training records.

F. Supervisors: Supervisory personnel shall be certified by Avixa (formerly InfoComm International) for type of work they oversee.

G. Installers: Installation of each item of A/V equipment shall be by installers certified by manufacturers for the specific equipment. Certified installers shall have attended training programs for each subsystem that prepared them to perform the work.

H. Technicians: Factory-certified to install and commission the work.

I. Manufacturer-Certified On-site Training Staff:

1. Certified on-site staff for specified remote-control hardware to provide product-line training, and service support training.

J. General Product Requirements:

1. Supplier Chain: Products shall be purchased from reputable supplier that has direct relationship with manufacturer's factory. Counterfeit devices are not permitted.
2. Listing: Underwriters Laboratories, Inc. (U.L.) or Technischer Überwachungs-Verein (TÜV) listed and approved where specifically specified or where normally subject to such U.L. or TÜV labeling and/or listing services.
3. Original Equipment Manufacturer (OEM): All accessories, including rack-mounting hardware and power supplies, shall be obtained from original equipment manufacturer. Third-party accessories are not permitted.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Space will not be provided at project site for purpose of pre-assembly and associated testing; any required pre-assembly and associated testing shall be conducted at facility supplied by Contractor.

1.7 COORDINATION

A. Coordinate with all trades to ensure electrical, telecom and any other unique requirements are completed.

B. The coordination shall include all backing and structures for displays, projectors, projection screens or other devices.

1. Coordinate with design to determine that appropriate raceways are in place.
2. Coordinate with related trades to schedule the Work and ensure complete and integrated installation.
3. Coordinate wall backing for wall-mounted elements to ensure adequate support.

C. A/V systems subcontractor shall identify cable types, quantities, lengths, and final locations to be terminated. That information shall be supplied to General Contractor and low-voltage cable subcontractor. It is Contractor's responsibility to ensure that this information is complete and accurate.

1.8 WARRANTY AND MAINTENANCE SERVICE

A. Commencing on the date of Substantial Completion, provide one year of warranty covering all work, systems, and subsystems against defects in materials and workmanship shall include the following:

1. When necessary, supply temporary loaner equipment that is fully compatible with A/V systems for any equipment not field-repairable and requiring replacement. Loaner equipment that shipped to/from the manufacturer or distributor shall be on site and operational within one week of component failure.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE FOR A/V SYSTEMS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden, Inc.
2. Gepco International.
3. Commscope, Inc.
4. West Penn Wire.

B. Cable Application: Signal type is indicated, on A/V schematic diagrams in Construction Drawings, at equipment input or output.

C. Cable Jacket: Plenum-rated.

D. Cable Types:

1. Microphone and line cable.

a. Plenum Configuration: Type CMP, 0.64mm (22/2 AWG) (7x30) stranded twisted shielded pair with overall shield.
b. Properties: 17 ohms /M'.
c. Size: 3.4 mm OD.

2. Speaker cable.

a. Speaker runs of over 25.4m (100')
b. Configuration: Type CMP, 2mm^2 (#12 AWG) stranded twisted pair
c. Properties: 1.7 ohms/254m (1000')
d. Size: 6.8mm OD
e. Speaker runs between 12.7m (50') and 25.4m (100')

1) Configuration: Type CMP, 1.6mm^2 (#14 AWG) stranded twisted pair
2) Properties: 2.66 ohms/254m (1000')
3) Size: 5.53mm OD

f. Speaker runs less than 12.7m (50')

1) Configuration: Type CMP, 1.5mm^2 (#16 AWG) stranded twisted pair
2) Properties: 4.38 ohms/254m (1000')
3) Size: 4.62mm OD

3. Video tie line cable.

a. RG6/U coaxial cable; see Section 271505, "Communication Horizontal Cabling."

4. HDMI (High-Definition Multimedia Interface)

a. Carries video, audio, and auxiliary data from source to display devices
b. Up to 18 Gbit/s in HDMI 2.0 via (TMDS) Transition-minimized differential signaling.
c. Connector types A-E
d. Based on EIA/CEA-861 standard

5. Digital video/audio (unbalanced) tie line cable one conductor.

a. RG6/U coaxial cable; see Section 271505, "Communication Horizontal Cabling."

6. Digital video F/UTP tie line cable.

a. Category 6 SHIELDED (F/UTP); see Section 271505, "Communication Horizontal Cabling."

7. Data tie line cable.

a. Category 6 (UTP); see Section 271505, "Communication Horizontal Cabling."

8. Control and communication cable, as required for DSP configuration:
9. Fiber optic cable (with media converters), single mode and multi-mode; see Section 271305 "Communications Backbone Cabling" and Section 271505 "Communication Horizontal Cabling."

2.2 TECHNICAL PANELS

A. Technical panels are any specialty panels which need to be designed and fabricated to support the A/V design and deployment. The panels could be custom panels for unique audio or video designs.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. RCI
2. Snyder Electronics
3. Wireworks

C. Configuration: As detailed on Construction Drawings.

D. Wall Box Cover Plates:

1. Material: Stainless steel.
2. Finish: Natural.
3. Engraving:

a. 3.5 mm letters with black fill paint.
b. Device numbering shall be as indicated on Construction Drawings.

E. Pull Box Cover Plates:

1. Material: 2 mm (14 gauge) steel with three-layer lamacoid engraved covering.
2. Finish: White.
3. Engraving:

a. Panel Title: 5 mm letters with yellow fill paint.
b. Device: 3.5-mm letters with white fill paint.

2.3 A/V EQUIPMENT FLOOR BOXES AND CONNECTION PLATES

A. Floor Boxes:

1. Coordinate floor box model with those selected for electrical systems in Section 262725 "Wiring Devices."
2. Size box for conduit by electrical subcontractor. Furnished by electrical subcontractor.

B. Internal A/V Connection Plates: Selected by A/V subcontractor.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Custom AV Solutions.

2.4 EQUIPMENT RACKS AND CREDENZAS

A. Rack Frames for A/V, General

1. The A/V rack is different from the IT or Telecomm rack.

a. Provide a 45 RU (78.88"/200.36 cm) of mountable equipment space.
b. The height of the rack shall be 82.88"/2120.52 cm.
c. The depth of the rack shall be a minimum of 32"/81.28 cm.
d. The rack shall be black in color, unless otherwise noted by the customer.
e. The rack shall be seismic rated.

2. Cooling for the rack accessories:

a. Configuration: Top panel with fans, side panels, and blank/vent panels for proper forced cooling. Fan CFM properly sized to maintain an internal rack temperature of no more than 85°F [30°C]

3. Provide top panels for each rack with preconfigured fans and a controller. The fan volume shall be 552 CFM at 38 dBA.

B. Credenza Units:

1. The credenza units shall be custom built (free-standing or built-in) to include A/V integration provided Contractor.
2. A/V equipment and components within the credenza must be coordinated with the A/V Designer.
3. Built-in A/V credenza construction and materials shall adhere to Custom Grade requirements set forth in Architectural Woodwork Standards (latest edition).
4. The unit shall be sized for the space and coordinated with the design team.

a. The standard size shall be a 1 bay, 2 bay, or 3 bay credenza in width.
b. Each bay minimum 24"/60.96 cm depth, 32"/61.28 cm, the standard height, but it could vary based on A/V and Interiors design requirements.

c. Concealed heavy-duty recessed swivel casters with recessed, plinth base
d. Front and rear lockable doors
e. Doors that open in opposite directions to access sliding A/V racks.
f. Provide front and back-mounted rack rails for Rack Units
g. Ventilation fans and ventilation grilles on rear doors
h. Cable management throughout
i. Metal grommets (either at the top or within the cabinet base)

5. Additional Customizations if requested by Project Designer

a. Self-pull, integrated pull, tab pull, or handle pull for ADA accommodation (color to be selected)
b. Concealed integral trash receptacle
c. Concealed refrigerator
d. Drawers
e. Raised backstop at credenza top

6. Materials and Aesthetics

a. Case Material and Doors (Drawers if specified): Wood veneer, High-Pressure Plastic Laminate, or Painted finish (must match Project Designer's specification and control sample).
b. Top Material: Custom material and edge condition per Project Designer's specification. (Glass, Solid Surface, Quartz, Solid Wood, Natural Stone, High-Pressure Plastic Laminate).
c. Recessed Base (Toe Kick) Material: Wood Veneer or Metal Finish.
d. If wood veneer is selected for the case and door material, veneer direction will be provided by the Project Designer.
e. Door and cabinet thickness to be a minimum of 19 mm (¾") thick.
f. Hardware used for construction of the credenza shall adhere to the requirements set forth in applicable ANSI/BHMA Standards (latest edition).
g. Concealed door hinges shall be self-closing or provided with a catch.
h. Bumper pads shall be installed at the top and bottom of each hinged door.
i. Closing stops shall be provided at the rear of drawer sides unless the drawer slides contain integral stops that prevent the drawer face from impacting the cabinet body.
j. When design permits, and if stops are not integral to the drawer slides, a mechanism shall be provided to prevent the drawer from pulling out of the cabinet.
k. Drawer slides shall provide for a minimum extension of 75 percent of the length of the drawer box beyond the cabinet body.

C. Power Management Accessories:

1. Configuration: AC power.
2.

a. Provide rack-mounted power strips sized to power each device in the rack, plus 40 percent spare outlet quantity.

3. Product Types:

   a. Rack-mounted horizontal power distribution unit with multiple outlets, to include surge and spike protections and EMI filtering. One Rack Unit (RU) in height.
   b. Vertical power strip 60” (152cm) with twenty-eight outlets and digital current meter in amps.
   c. Wire Duct: Wide-slot wiring duct, sized as required.

4. Product Characteristics:

   a. Material: 1.6 mm (16 gauge) flanged steel panels.
   b. Finish: Textured black powder coat.
   c. Engraving:

      1) Panel Title: 5-mm letters with yellow fill paint.
      2) Device: 3.5-mm letters with white fill paint.

5. Device numbering as indicated on Construction Drawings.

   a. Configuration: As detailed on Construction Drawings.

6. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Middle Atlantic Products, Inc., BGR Series.
   b. Winsted Pro Series II.
   c. Atlas Sound FMA series.

2.5 ACCESSORIES

A. Connection Plate Receptacles:

   1. Audio (Microphone): XLR type.
   2. Audio (Line Level): 6 mm (¼ inch) diameter tip/ring/sleeve type, or as required by intercom system.
   3. Audio (Loudspeaker Level): Neutrik “Speak-On” Type.
   4. Video: BNC type.
   5. Display Port/Mini Display Port
   6. HDMI: HDMI jack.
   7. ACTXX/CAT (F/UTP)

B. Escutcheon and Trim Components:

1. A/V subcontractor shall furnish trim/escutcheon components where A/V components pass through finished ceilings. This includes, but is not limited to, video projector supports, flat-panel display supports, speaker mounts, and assistance listening devices, as applicable.

C. Cable Sheathing: Where cable will be visible in habitable areas, provide an expandable braided sleeving over the cable, the color shall match the environment where it is installed. The sleeving shall be cut cleanly and finished, with no open or loose strands protruding from the end.

D. Heat shrink tubing:

1. Where required on audio, control or other cables, the heat shrinkable tubing will be used on the cable near the connector to provide a clean finished product.
2. The heat shrinkable tubing colors shall be confirmed with the customer or technical representative before use.

E. Labels: all cables (audio, video, control, A/V network, power, grounding, etc.) in the A/V systems shall be labeled at both ends of each cable with the designated approved content.

1. Basis of Design: Pan-Code system by Panduit Corp. See Section 270553 "Identification for Communications Systems."
2. Permanent, self-laminating, wrap-around number or letter cable marker.
3. Label text and images shall be computer-generated for legibility.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas to receive the work and conditions under which the work will be performed. Remedy conditions detrimental to proper completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. It is the responsibility of the contractor to confirm all dimensions, all quantities and the coordination of materials and products supplied by the contractor with other trades.

3.2 GENERAL INSTALLATION

A. Scope of System Installation: Installation shall include fastening A/V components and equipment to walls, floors, ceilings, counters or other structures as indicated on Construction Drawings or as otherwise required; interconnecting wiring of the system components, alignment and adjustment of systems, and related installation necessary to result in complete and fully operational systems.

B. Follow factory recommended termination of cabling to utilize best industry practices and provide acceptable connectivity to approved devices

C. Provide pathway from any audio video device (projector, flat panel, camera, speakers, I/O devices, control location) to the designated location on the contractor drawings to facilitate connectivity of each element to the A/V System and all its components.

D. Utilize front side serviceable pull-out wall mounts to ensure both serviceability to end users and ease of installation

E. Utilize in wall back boxes for all display locations, where applicable. The back boxes are to be specified within the A/V specifications, provided by the A/V contractor and installed by the General Contractor or other responsible representative; see Section 262725 “Wiring Devices.”.

F. Equipment and cable layout shall be given not only recognize operational efficiency, but also overall aesthetic factors.

G. Installation at Receptacles:

1. Audio (Line Level): Insulate jack from panel type.
2. DVI: Isolate jack from panel type with hex nuts.
3. HDMI: Isolate from panel.
4. BNC, RF: Insulate receptacles from panel type.

H. Equipment Racks:

1. All A/V equipment racks/cabinets shall be CFCI. Install equipment racks in suitable locations to support A/V use as identified in Construction Drawings and in accordance with TIA/EIA standards and model NFPA 70.
2. Ensure that placement of racks allow for adequate ventilation and access.
3. Ensure the front rack rails are moved backward in the rack, to accommodate the handles, patch cables or any other equipment. The equipment shall not protrude past the front of the rack.
4. Mount vertical power strips to rear rack rails in the rear of the rack as required to accommodate the power requirements.
5. Provide power requirements per rack, number of amps, and number of circuits.
6. Electrically bond power strips and conditioning devices to rack grounding lug.
7. Patch panels and terminations are required when terminating for respective equipment racks specifically for A/V and all CAT-X cables.
8. Equipment Cabinets shall be seismic rated as required in accordance with ASCE/SEI 7.

I. General Physical Installation of System.

1. Fastenings and supports shall be adequate to support their loads, with safety factor of at least three times total load.
2. Affix permanent engraved plaque on equipment, denoting its function.
3. Secure boxes, equipment, and similar items plumb and square.
4. Pull Box Cover Plates: Bevel and remove sharp edges.
5. Trim and escutcheon components.

a. Install trim/escutcheon components A/V components pass through finished ceilings. Finish trim components at ceiling plane to match accepted ceiling finish system.

6. Mounting Locations and Mounting Heights: Coordinate with Construction Drawings:

a. Technical Wall Plates:

1) A/V input/output connections.
2) Flat panel display panel connections.
3) Video projector connections.
4) Annotation panel connections.
5) Networked digital clocks.
6) Wall-mounted speaker boxes.
7) Device control locations.
8) Device lifts or other technical device locations.

b. Control panels.
c. Pull boxes.

1) Pull boxes are any location where a cable must be deployed and it ends or proceeds through the box to another location. An example would be the Screw Cover (SC) box associated with the rack or credenza locations. The wall (PAC) boxes behind displays, speaker boxes, and other locations.

3.3 CABLE INSTALLATION

A. General:

1. See Section 271305 “Communications Backbone Cabling” and Section 271505 “Communications Horizontal Cabling” for general cabling installation requirements.
2. Install cables with continuous lengths without splices from origination to rack.
3. System wire, after being cut and stripped, shall have wire strands twisted back to their original lay. Terminate wire by soldered or mechanical means.
4. Except where identified otherwise in Construction Specifications, no bare-wire terminations are permitted.
5. Insulate ground or drain wire with heat-shrink tubing.
6. Unused wires at end of cable shall remain unstrapped, be laid back, and held in place with wire ties.
7. Do not install cable with bend radius less than that recommended by cable manufacturer.
8. Cut cables to length dictated by run; the exception is video and pulse cables, which shall be cut to electrical length. Splices are not permitted in pull boxes.
9. For equipment mounted in drawers or on slides, install interconnecting cables with service loop of appropriate length.
10. Fiber Optic Cables: Route and terminate fiber optic cables in accordance with TIA/EIA standards.

B. Marking:

1. Mark cables, regardless of length, with permanent cable marker at both ends. Ensure that computer-generated markers are installed; temporary wire labels done by hand in field shall be replaced with computer-generated labels.
2. There shall be no unmarked cables at any place in system.
3. Marking codes used on cables shall correspond to codes shown on Construction Drawings and/or run sheets in construction submittals.
4. Wire markers shall face common direction.

C. Grouping:

1. Grouping by Signal Type: Group cables according to signals being carried. To reduce signal contamination, form separate groups for the following cable families:

   a. Power cables.
   b. Network/Control cables.
   c. Shielded CAT X/Video cables.
   d. CAT X/Audio cables carrying signals.

2. Arrangement of Groups: As general practice, arrange groups as follows:

   a. Run power cables, control cables, and high-level cables on left side of equipment rack as viewed from rear.
   b. Run other cables on right side of equipment rack, as viewed from rear.

D. Bundling:

1. Wire bundles shall be neat and combed free of cable crossovers.
2. CableVelcro Wraps: Place cables ties at appropriate intervals of no greater than 150 mm (6 inches) for vertical bundles, and 50 mm (2 inches) for horizontal bundles.
3. No cable ties are to be used for any cable bundling.

E. Cable Support:

1. Support in accordance with Section 260508 “Common Work Results for Electrical, Communications, and Electronic Security.”
2. Support of Individual Runs Support of Individual Runs:

   a. Support cable at 1500 millimeters on center and 750 millimeters at any change in direction with J-hooks.
   b. Support cable from building structure.
   c. Placing cables on top of ceiling panels and ceiling tiles is not permitted.
   d. Support of cable from ceiling grid support wires is not permitted.

3. Support of Cable Bundles:

   a. Where multiple cables combine, support at 1500 millimeters on center and 750 millimeters at any change in direction with J-hooks. Support from building structure.
   b. Placing cables bundles on top of ceiling panels and ceiling tiles is not permitted.
   c. Support of cable bundles from ceiling grid support wires is not permitted.

F. Cable Connections:

1. Solder Connections: Make solder connections with rosin-core solder using temperature-controlled solder stations. Take care to avoid cold or cracked solder joints. Any connections that do not appear to be clean and shiny, or which show signs of cracking, shall be re-soldered prior to final acceptance of system.
2. Crimp-Type Mechanical Connections: Bond mechanical connections that use insulated, crimp-type connectors to connector by soldering wire to metal part of connector.
3. Pressure-Type Mechanical Connections: Connections made with screw-actuated pressure-type terminal strips shall be made by stripping approximately 6 mm (¼ -inch) of insulation from stranded conductor. Then insert un-tinned wire into terminal and tighten screw, using secure fitting precision screwdriver.
4. Connector Housing: Connectors shall have proper connector housing.
5. Video Cables: Unless otherwise indicated on Construction Drawings, terminate analog video and computer video cables using 75-ohm connectors with captive center pin.

G. Cable Interfaces:

1. Terminal blocks, boards, strips or connectors shall be used for cable interface with racks, cabinets, consoles, and equipment modules.
2. No audio cables shall run directly to audio patch panel jacks.
3. Audio patch panel shall be installed using audio terminal block; audio cables to and from audio patch panel shall terminate on this block.

H. Installation at Racks and Credenzas:

1. Cables shall not protrude from back of racks.
2. Cable entry shall be through tops of racks or through entrance holes in base of rack. No cable shall enter racks through front, rear or side-panel openings.
3. Attach vertical cable bundles to rack frame.
4. Neatly train and lace cables.
5. Route cables from components to lacing bars that are installed on the rear rack rail.
6. Provide service loops for each cable.
7. Rack Cable Separation: Cable separation of cables for runs within equipment rack shall be per the AVIXA guidelines, as follows:

   a. Microphone Level: 50 mm from other circuits.
   b. Line Level and Control: 50 mm from circuit with signal of 20 dB or with signal greater than line level and control cables.
   c. Speaker Level Circuits: 50 mm from other circuits.

d. Video and Data: 50 mm from circuit with signal of 20 dB or with signal greater than video and data.
e. AC Power Circuits: 50 mm from other circuits.
f. 90 degree crossovers are permitted.

8. Plenum Areas: Cables running in plenum areas without conduit shall be plenum-rated cable and shall match cable specified in the Part 2 Article on WIRE AND CABLE FOR A/V SYSTEMS. Verify in what spaces plenum cable shall be used.
9. Architectural Niches: Cables shall be black, unless otherwise directed to reduce visibility by Project Director/COR.
10. Visible Installations in Habitable Areas: Sheath cables in color wrap as selected for each location.

I. Cable Separation: For runs greater than 7.5 meters provide the following separation:

1. Microphone Level: 300 mm from other circuits.
2. Line Level and Control: 300 mm from circuit with signal of 20 dB or with signal greater than line level and control cables.
3. Speaker Level Circuits: 300 mm from other circuits.
4. Video and Data: 300 mm from circuit with signal of 20 dB or with signal greater than video and data.
5. AC Power Circuits: 300 mm from all other circuits.
6. 90 degree crossovers are permitted.

3.4 WIRE TERMINATION

A. Solder connections for connectors utilizing solder cups.

B. Utilize terminal strip connectors for termination of blunt cut cables. Tin cable prior to termination.

C. Multi-Pin Connectors: Utilize connector manufacturer's crimper.

D. Crimp cap terminations for loudspeaker circuits at individual devices. Utilize terminal strip connectors for distribution cable termination.

E. Do not tin cable ends when using captive screw connectors.

3.5 GROUNDING OF A/V SYSTEMS

A. General: Because of great number of possible variations in grounding systems, it is responsibility of Contractor to follow good engineering practice, as outlined above, and to deviate from these practices only to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems. Comply with Section 270526 "Grounding and Bonding for Communications Systems and the requirements below"

B. System Grounds: Establish single primary "system ground" for systems in each particular area. Grounding conductors in that area shall connect to this primary system ground.

C. Install system ground in audio equipment rack for the area consisting of copper bar of sufficient size to accommodate all secondary ground conductors. Copper conductor having maximum of 0.1 ohms total resistance shall connect primary system ground bar to nearest approved electrical ground. Contractor is responsible for determining if metallic conduit is properly electrically bonded to building ground system.

D. Install secondary system grounding conductors from all racks, audio consoles, and grounding points for area. Each of these grounding conductors shall have a maximum of 0.1 ohms total resistance.

E. AC neutral conductor, either in power panel or in receptacle outlet, shall never be used for system ground.

F. Audio Cable Shields:

G. For ungrounded portable equipment, such as microphones, connect shield at both ends but grounded at only one end.

H. Video Receptacles: Insulate video receptacles from mounting panel, outlet box, and wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.

I. Audio Receptacles: Insulate audio receptacles mounting panel, outlet box, and wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.

3.6 FIELD QUALITY CONTROL

A. Pretesting: Before Acceptance Tests are scheduled, Contractor shall perform his own system check out. Contractor shall supply all necessary test equipment. Contractor shall perform work necessary to determine and/or modify performance of system to conform to requirements of this Section. This work shall include the following:

1. Test Equipment and Supplies: Utilize the test equipment and supplies identified below; adjust as necessary for project-specific design.

a. Audio Checking:

1) Audio generator, and measurement tool, Audio tools App or equal.
2) Audio cables.
3) Set of terminations, adapters, and similar items.

b. Video Checking:

1) 4K Video signal generator, Extron or approved equal.
2) Pre-recorded Media as appropriate to playback devices.
3) Video cable.
4) Set of terminations, 'T' pieces, and similar items.

2. Network Testing

a. Verify supplied cable test reports with Contractor supplied test equipment.

3. Controlling Functions: Check control functions from controlling devices to controlled devices for proper operations.
4. Whenever possible, include computer sources provided by USG at desired resolution in testing.
5. Adjustments:

a. In conjunction with pretesting process, adjust, balance and align A/V equipment for optimum quality and to align with manufacturers' published standards. Establish and mark normal settings for level controls.
b. Check and adjust optical projection images for average light level, light fall off, and image alignment, and size images to comply with performance standards and with design reflected in Construction Documents. Check that projectors, projector bases, carts, tables and mirrors are rigid and vibration-less in operation; adjust as necessary.

B. Systems Acceptance Testing:

1. A/V system Acceptance Tests will not be performed until Contractor's system pretesting has been completed, and pretesting results have been accepted. System Acceptance Tests will be supervised by USG representative identified by Project Director COR, based upon input from OBO/PDCS/DE/EE, and shall consist of the following:

a. Physical inventory of A/V equipment compared to Equipment Schedule from Construction Submittals.
b. Operation of system equipment demonstrated by factory-certified technicians or manufacturer-certified training staff.
c. Acceptance Testing shall provide documented results that provide proof of a fully functional system, with all functionality have demonstrated to USG representative and/ responsible end-user in person during Acceptance Testing.
d. All touchpanel Control functionality shall be demonstrated during the Acceptance Testing process.
e. Both subjective and objective tests are required to determine compliance with Contract Specifications. Contractor is responsible for supplying test equipment for these tests.
f. Record/Redline Drawings, run sheets, uncompiled set of source codes, O&M Manuals, Pretesting Results spreadsheets, and other required documents shall be on hand prior to scheduling Acceptance Tests, with one complete set delivered to USG representative prior to scheduling of tests, and one set to Project Director/COR.

g. During Acceptance Testing, in the event further adjustment is required to conform to specified performance requirements, or defective equipment requires repair or replacement, Acceptance Tests may be suspended or continued at discretion of Project Director/COR based upon input from OBO/PDCS/DE/EE.
h. Any charge for additional time incurred by USG representative required to oversee System Acceptance Tests, due to improper system installation or previous failed systems, is the responsibility of, and charged directly to, the Contractor.

3.7 CLEANING AND PROTECTION

A. Clean up and repair all areas affected by this work. Protect exposed surfaces with materials that are easily removed without marring finishes.

B. Contractor is responsible for protection of work from damage or loss due to either man-made or natural causes.

C. The work and storage areas are to cleaned daily of any trash or other debris, presenting a safe work environment.

3.8 DEMONSTRATION

A. Provide training in a two-session formats. The on-the-job training shall be by an instructor who is fully knowledgeable in design and operation of systems. Training shall take place after the systems are operational, but not before system acceptance has occurred. Training shall be for A/V systems in major spaces such as Multi-Purpose Room, Gallery/Atrium, Large Conference Rooms, and Classrooms. Training shall be for the following users as identified by the Project Director/COR:

1. Train system users and administrators.
2. Train technical-support personnel.

B. For each of these sets of trainees, provide minimum of eight hours of training provided in one-hour sessions. Training session set shall be recorded on video.

C. System user training shall include the following material and topics:

1. The operation of the total of audiovisual system and each sub system or room system.
2. Connection of source devices.

a. Microphones.
b. Computers
c. Control Panels
d. Audio devices
e. BYOD (bring your own device-if applicable)
f. Other devices as required per the system design

3. Run through of mock meeting/events based on room use cases.

D. Technical-support personnel training shall include the following material and topics:

1. Operation and replacement of common replacement items.
2. General care and systems maintenance.
3. Digital Audio configuration and switch settings.
4. Provide instruction on frequency of UPS battery replacement and replacement process.
5. Process for resetting system.
6. Hardware Chassis configuration, replacement of modules and chassis.
7. Software loading and configuration.
8. Support phone and e-mail contact information.

END OF SECTION 274100

SECTION 274114 – ARCHITECTURALLY-INTEGRATED AUDIOVISUAL ELEMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this section includes the integrated audiovisual (A/V) systems but is not necessarily limited to the following:

1. Video Displays.
2. Audiovisual (A/V) Mounting Devices.
3. A/V Cameras
4. Audio Systems.
5. Assisted Listening Systems.

B. Related Sections include the following:

1. Section 274100 “Audiovisual Systems General Requirements.”
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
3. Section 270645 “Schedules for Audiovisual Systems.”
4. Section 274100 “Audiovisual Systems General Requirements.”
5. Section 275105 “Consular Audio Systems for Consular Services;” those systems are not related to the work of this Section.
6. Section 275405, “Consular Queue Management Infrastructure and Displays;” those displays are not related to the work of this Section.

C. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

D. See Section 274100 “Audiovisual Systems General Requirements” for additional general A/V reference standards.

1.2 SUBMITTALS

A. Consolidate with submittals in Section 274100 “Audiovisual Systems General Requirements.”

B. The submittal package shall include all documents which support the A/V design and installation, at the minimum but not limited to the following:

1. Control system pages and flow diagram
2. Drawings – build to details
3. IP Information Sheet (which is a living document)
4. Data product sheets
5. Room and Equipment detail sheets
6. Cable Runs sheets
7. Finish Schedules for furniture:
8. Spare parts list

1.3 ADA COMPLIANCE

A. The AV systems shall be deployed in accordance with ADA standards, coordination between the design and integration teams will be required.

1.4 QUALITY ASSURANCE

A. Approvals: To ensure active equipment is in accordance with government policy, active equipment used for video teleconferencing must be approved through OBO/PDCS/DE/EE.

PART 2 - PRODUCTS

2.1 SAMPLE ROOM LARGE CONFERENCE – OBO DESIGN

A. Reference audiovisual Systems Drawings.

B. This room is a room which supports meetings or presentations and collaboration.

C. Single large display wall mounted on pop out mount.

D. Two table inputs and Collaboration system.

E. The Control Unit Interface (CUI) unit will incorporate the Collaboration control features and the room AV control features into a single panel.

F. Microphone arrays for audio pickup.

G. Playback and voice reinforcement system.

H. Control System

1. The Customer User Interface (CUI) panel will be a tabletop unit.

2. The CUI shall have tiered functions and rites and user controls configured as noted below.

    a. Display system: on / off
    b. The CUI shall be the main method for source selection and content management of the video display, not the manufacture software.
    c. The ability to select a source and send it to the display.
    d. Provide the capability to have all the computers, in room cameras, conferencing sources, CATV/IPTV, and other signals as sources.
    e. The ability to hit the “Sanitize” button and have a clean image routed to the displays.
    f. CATV/IPTV channel selection and controls, presets (6), up / down and number pad with network logos or local network identifiers, channel numbers will not be acceptable.
    g. Provide filters or other methods which reduce the effort and time required to find and or select a source.
    h. Provide technical user pages with all switch and device control capabilities, which provide the detailed information for each device and the health status using a (red, and green) format.
    i. Provide interaction with the room sensor for system startup and shut down, during normal working hours the system shall be in a suspended state for quick start up.
    j. Provide a system shutdown at a prescribed time each day for the A/V systems, the time will be selectable via the technical user pages on the CUI.
    k. Provide volume controls:

        1) The control shall be via a slider bar for the playback and reinforcement speakers with mute controls for each system.
        2) There shall be a limit set on the audio to limit the volume in the room.
        3) The playback and reinforcement speakers shall be on independent controls.
        4) The overall mute controls shall mute the complete room.
        5) All speaker zones shall be controllable.

    l. There shall be six (6) camera presets for each camera when it is selected via the control system. The presets shall be user defined as needed, not hard coded.
    m. Provide detailed user control functions for the collaboration unit on the CUI, the features of the manufactures control unit shall be integrated into the CUI. The detail shall include the following at a minimum but not all functions are listed:

        1) Call startup.
        2) Call hang-up.
        3) Last number dialed.
        4) Phonebook support if required.
        5) Multisite call support if required.
        6) Graphic content support.

3. Provide a table based, ten-inch customer user interface unit.

    a. 10” capacitive touchscreen with 1280x800 resolution and 24-bit color.
    b. Optically bonded glass.

c. Product is powered directly by a PoE+ switch or injector.
d. Ultra-fast quad-core processor.
e. Auto Brightness.
f. System connection status indicator provides visual feedback if the touch panel is not communicating with a control processor.
g. The unit will connect at the table modular unit and then to the floor box.

4. Provide an Ethernet-enabled control processor for the purpose of remotely controlling, monitoring, and troubleshooting connected AV equipment and AV systems.

a. Ethernet-enabled control processor
b. Six RS-232 ports on captive screw connectors located on the back of the processor that can be used for unidirectional or bidirectional control of AV system components.
c. Two RS-232/RS-422/RS-485 ports on captive screw connectors located on the back of the processor that can be used for unidirectional or bidirectional control of AV system components.
d. Eight IR/Serial ports on captive screw connectors located on the back of the processor. These ports shall allow the transmission of IR signals (using an IR emitter) or unidirectional RS-232 communications for control of AV system components.
e. Eight low voltage relays on captive screw connectors located on the back of the processor that can be used to control lighting, screens, or other device functions.
f. Four flex I/O ports on captive screw connectors located on the back of the processor that can be used as analog inputs in addition to digital input or a digital output that can be used to interface with devices such as sensors, switches, LEDs, and relays.
g. Four, independently switched 12-volt outputs on captive screw connectors located on the back of the processor that can provide a combined total of 40 watts of power for powering auxiliary devices.
h. Device shall have a female RJ-45 jacks located on the back of the enclosure that supports 10/100/1000Base-T, half/full duplex with auto-detect for connection to a LAN or WAN and includes link and activity LED indicators located on the left and right of the jack for troubleshooting network issues.
i. Device shall have a second female RJ-45 jack located on the back of the enclosure that supports 10/100/1000Base-T, half/full duplex with auto-detect for connection to a LAN or WAN and includes link and activity LED indicators located on the left and right of the jack for troubleshooting network issues, this port will be designated as an AV LAN port allowing for AV devices to be isolated from a corporate network.
j. Device shall include a multi-function button that allows for the reset of the device or its communication properties at minimum.
k. Supports a web-based AV resource management application that provides a means to manage, monitor, and control AV equipment.
l. Provide an internal real-time clock with backup battery that is used to keep track of the date and time.
m. Device shall provide the option to modify administrator and user credentials.
n. Device shall support security updates to maintain network health.

o. Device shall require that a Secure Socket Layer (SSL) Certificate is installed to maintain system confidentiality and data integrity.
p. There will be a control panel provided as part of the VTC/Collaboration unit, its functions will be integrated into the CUI for the AV system.

5. The system will activate when a computer is plugged in, the CUI is touched, or the room occupancy sensor is triggered.

I. Display Systems

1. Provide one (1) 98”, 16:9 aspect ratio UHD LCD units for the wall.

a. The unit shall have a no-glare commercial grade LCD panel.
b. The unit shall have a brightness of 500 nits.
c. The unit shall be rated for 24/7 operation.
d. The unit shall support AC power at 110-240V, 50/60 Hz.

2. The display shall be wall mounted utilizing a low-profile tilt mount on the display with mount wall pop out brackets. There shall be three mounting points for the display/wall pop out brackets.

a. Tilt mount unit:

1) Integrated teardrop design speeds up wall plate installation by allowing pre-installation of the bolts to the wall.
2) Centerless Shift provides up to 17.5" (445 mm) of post-installation lateral shift - 8.75" (222 mm) left/right of up rites - for limitless centering.
3) Low-profile tilt uses the center of gravity to balance the screen while maintaining a low profile.
4) Set screws keep the mount rigid, stable and secure throughout the life of the installation.
5) An audible click when the screen safely engages with the mount.
6) Built-in cable stand provides easy access under the screen

b. Pop Out brackets:

1) Up to 11.54” (293 mm) extension when combined with Fusion mount - great for recessed applications
2) Scissor assembly extends out up to 9.5"
3) Plumb adjust to keep display in line with the wall
4) Latch to secure mount in home position
5) Compatible with extra-large micro-adjustable fixed and tilt mounts for installation

3. The in-wall display support back box will incorporate the power and the AV connection plates, color of the box is to be confirmed before ordering.

a. The unit shall have overall dimensions of (HxWxD) 15.51 x 15.4 x 3.88” (394 x 391 x 98mm).
b. The units shall be equipped with a local power connection to support the display and other equipment.

4. Coordinate location of display in the room with the customer, to ensure proper mounting location.

J. Video and Data Systems

1. Provide VTC/Collaboration room kit consisting of a codec, camera, and CUI.
2. The codec unit shall be mounted in the equipment enclosure. The unit shall have the following features:

a. Minimum bandwidth for resolution/frame rate: H.264, 720p30 from 768 kbps, 720p60 from 1152 kbps, 1080p30 from 1472 kbps, 1080p60 from 2560 kbps
b. Video inputs:

1) One HDMI input supports formats up to maximum 1080p60
2) Two HDMI inputs support formats up to maximum 4K (3840 x 2160) at 30 fps including HD1080p60
3) Two HDMI outputs which support up to 3840 x2160.
4) Extended Display Identification Data (EDID)
5) Consumer Electronics Control (CEC) 2.0

3. There shall be a wall mounted camera unit mounted below the display with:

a. Video output at 1080p
b. Support up to 60 fps
c. 10 optical zoom, 2 x digital zoom, 20 x total zoom
d. 80° horizontal field of view; 548.8° vertical field of view
e. Auto focus, brightness, and white balance
f. Focus distance 1 m to infinity

4. The control function will be integrated in the main CUI in the control section.
5. The system shall have an auto wakeup feature when people walk into the room, the occupancy sensor shall work in conjunction with the A/V equipment.
6. Provide one camera control/video extension system with wall bracket:

a. The extension unit shall be based upon HDBaseT technology
b. Power, video and control over a single STP cable up to 328 ft. (100m)
c. Bridges audio and video for easy soft-client conferencing
d. Simultaneous HDMI, USB 3.0, and HD-SDI outputs
e. Up to 1080p/60 resolution available over uncompressed USB
f. Includes thin profile wall mount bracket -black

7. Provide a modular, configurable, and furniture-mountable enclosures that shall support a combination of AC power modules, A/V cables, and other plates, the unit shall be configured with:

    a. Provide one - AC-plus-USB power modules, the module shall provide two outlets AC and two USBA charging ports in a single module.
    b. USB power outlets shall provide 5 volts Direct Current and up to 2.1 amps, or 10.5 watts of power.
    c. Provide one HDMI female to female with a 10” pigtail on a single space plate, to be installed in the table box.
    d. Provide one DP to DP with a 10” pigtail on a single space plate, to be installed in the table box.
    e. Provide one RJ45 CATX punch down connector plate, to be installed in the table box for CUI connection.
    f. The table connections will connect to the switcher/transmitter unit.
    g. The modular table device shall have the following features:

        1) The device shall include modules and mounting frames to support AC or AC-plus-USB power, A/V cables and/or A/V connectivity plates.
        2) AC power modules shall be UL listed and CE compliant when installed within the enclosure. AC power modules shall include an attached AC power cord or IEC power inlet with detachable AC power cord, as required by local electrical power codes and conventions.
        3) Device shall include an attached and fully integrated, all metal lid and bezel assembly.
        4) The lid and bezel assembly shall be available in a black anodized or brushed aluminum finish, the finish shall be black as a default unless directed by the customer.
        5) Device lid shall fit entirely within the bezel, when closed, the lid shall provide a full width opening for cable pass-through. When open, the lid shall articulate such that it fits within the enclosure body. Device shall include a damper that controls the speed of the lid as it moves within the enclosure.
        6) The enclosure shall feature an integrated clamp system, the clamps shall be permanently affixed to the enclosure body. The clamps shall utilize a lever-and-cam mechanism.

8. Provide a 4K auto switcher/ transmitter extender over STP with a connection to a matrix switcher, to support each table box with the following features:

    a. Transmits DisplayPort (DP), HDMI, control and analog audio up to 330 feet (100 meters) over a shielded CATx cable.
    b. Inputs: two HDMI, one DP, one 3.5 mm stereo mini jack for audio.
    c. One STP transmitter output.
    d. Supports computer and video resolutions up to 4K/60 @ 4:4:4.
    e. Auto-switching between inputs.
    f. Analog stereo audio embedding.

g. Supports HDMI 2.0b - data rates up to 18 Gbps, High Dynamic Range (HDR), Deep Color up to 12-bit, 3D, and HD lossless audio formats.
h. Supports DisplayPort Single Stream Transport (SST) data rates up to 21.6 Gbps.
i. Support for HDR video.
j. Remote power capability.
k. 24 shielded twisted pair is recommended for optimal performance
l. Output is compatible with High Definition Base T (HDBaseT) -enabled devices — The STP output can be configured to send video and embedded audio, plus bidirectional RS 232, and IR signals to an HDBaseT-enabled display.
m. The unit will connect at the table and then to the floor box.

9. Provide a 4K HDMI receiver unit for the display at the backbox with:

a. Receives HDMI plus control and analog audio up to 230 feet (70 meters) over a shielded CATx cable.
b. Input: One twisted pair input on RJ-45
c. Outputs: One HDMI, stereo audio on captive screw.
d. Supports computer and video resolutions up to 4K/60 @ 4:4:4.
e. Supported HDMI 2.0b specification features include data rates up to 18 Gbps, HDR, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
f. Support for HDR
g. HDCP 2.3 compliant
h. Remote power capability
i. Bidirectional RS 232 and IR pass-through for AV device control.
j. Supports EDID and HDCP transmission.
k. 1” (2.5 cm) high, quarter rack width metal enclosure.

10. Provide a 10x8 scaling presentation matrix switcher to support the switching requirements within the space, the unit shall have the following features:

a. Provide six HDMI video input connections.
b. Four RJ-45 for video from STP twisted pair transmitters.
c. Support 4K and UHD signals at all inputs.
d. Provide image adjustments for the STP outputs, including brightness, contrast, color, tint, detail, H/V positioning, and sizing.
e. Automatic memories for each video input.
f. User presets may be saved and recalled electronically via Ethernet, RS-232, or USB connection.
g. Support HDMI specifications including data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, and HD lossless audio formats.
h. Provides automatic cable equalization for each digital input to 100 feet (30 meters) at 1080p/60 with 8-bit color.
i. Provide automatic cable equalization for each digital input to 50 feet (15 meters) at 4K/30 and 2560x1600 @ 60 Hz resolutions.
j. Support video transmission over shielded CATx up to 330 feet (100 meters).
k. Video output connections six HDMI.
l. Two dedicated RJ-45 for video to STP twisted pair receivers.

m. Shall support up to 16 logo presets.

11. Provide an A/V network managed switch for the display control, audio, and other task, per the system drawings.

    a. The switch shall be deployed in the equipment enclosure.
    b. The switch is detailed on the budget sheet.
    c. The switcher shall support:
    d. Network ports 24 10/100/1000 Ethernet copper ports
    e. Network ports 2 10G SFP+ ports uplinks
    f. POE+ power on 24 ports
    g. The unit shall be provided with a three-year maintenance support contract to minimize any down time.
    h. The connections and locations shall be connected per the system drawings.

12. Provide and install all the distribution units, cables, shelves, and other equipment required to make a complete and working system per the drawings and equipment list.

K. Audio Systems

1. Provide a ceiling table microphone array unit.

    a. The ceiling array microphone shall consist of eight highly directional pickup lobes to capture individual talkers and deliver discrete audio signals over a single network cable.
    b. It shall support 10 total channels (8 independent transmit channels, 1 automatic mixing transmit channel, and 1 audio echo cancelation (AEC) Reference Input receive channel).
    c. Audio routing shall be controlled through a computer on the Dante™ or AES67 network.
    d. Browser-based control software shall provide steerable coverage with ability to aim individual lobes based on participant seating.
    e. Pickup lobe width shall be selectable, with narrow, medium, and wide settings.
    f. Mounting options shall include hard ceiling, suspension mounting, and VESA mounting options.

2. Provide a fixed audio Digital signal Processing (DSP) unit with:

    a. The unit shall support Dante™ digital audio networking that shall allow up to 32 x 32 channels. The Dante networking connection shall be implemented on a RJ-45 connector.
    b. The audio DSP shall include 4 channels of General-Purpose Input and Output connection (GPIO) for sending or receiving logic signals. The programming of the GPIO ports shall be software configurable.
    c. The audio DSP shall include a RS-232 connection for control data transmission into or out of the audio DSP and such operation shall be software programmable.

d. The audio DSP shall include a Universal Serial Bus (USB) connection on a standard USB-B type connector.
e. The audio DSP shall be software configurable to stream up to 8 channels of digital USB Class 1 Audio transmission either into or out of the audio DSP or simultaneous input and output.
f. The audio DSP shall provide 12 balanced input connections for receiving of microphone or line level analog audio signals on screw-down, removable connectors.
g. The input connections shall include Acoustic Echo Cancellation (AEC) hardware and firmware, the parameters, routing, and operation of which shall be software programmable.
h. The audio DSP shall provide 8 balanced output channels for the transmission of microphone or line level analog audio signals on screw-down, removable connectors.
i. Each individual channel shall have its own dedicated connection. The audio DSP shall integrate to Voice Over Internet Protocol (VoIP) systems on a RJ-45 connector for two lines of VoIP communication and shall support Session Initiation Protocol (SIP) v2.0 or later.
j. The audio DSP shall integrate to standard telephony communications on a RJ-11 connector for a single line of telephone communication.
k. The audio DSP shall provide front panel OLED identification of device power, status, alarm, and activity as well as system-wide alarm.
l. The audio DSP shall be rack mountable (1RU) and feature software-configurable signal processing, including but not limited to signal routing and mixing, equalization, filtering, dynamics, and delay, as well as control, monitoring, and diagnostic tools.
m. The audio DSP shall be CE marked, UL listed, and shall be compliant with the RoHS directive.

3. Provide ceiling mounted speakers for voice reinforcement and mix minus with the following features:

a. 6.5" (165 mm) long throw woofer
b. 3/4" (19 mm) ferrofluid-cooled dome tweeter
c. 4.2" (107 mm) deep low-profile composite back can
d. Frequency range: 85 Hz to 20 kHz
e. 95° conical dispersion
f. 65 watts continuous pink noise
g. 130 watts continuous program
h. Locking arms support ceilings up to 2.25" (57.1 mm) thick
i. UL 2043 plenum rated enclosure

4. Provide playback speakers mounted on the sides of the display.

a. The speaker shall be sized to match the height of the display.
b. The speaker shall be mounted to the display mounting bracket and the surface of the speaker is to be smooth with the display surface.

c. The speakers shall be no more than 2.75" deep
d. Ribbon high-frequency driver for superior speech clarity.

5. Provide amplifiers units for playback and voice reinforcement audio devices.

a. Playback unit with Dante' interface.
b. Receives audio from the Dante audio network and from analog mic/line level inputs
c. Selectable output power modes
d. Two 100-watt channels into 8 ohms or 4 ohms
e. ENERGY-STAR qualified amplifier with defeat able auto-standby and fast wake up
f. Voice reinforcement unit with Dante' interface
g. Receives audio from the Dante audio network and from analog mic/line level inputs
h. Two 100 watts rms output power per channel at 70/100V
i. ENERGY-STAR qualified amplifier with defeat able auto-standby and fast wake up

6. AV contractor shall coordinate the installation of all required software with the owner's representative.

L. Furnishings / Miscellaneous

1. Provide a custom AV designed Credenza unit which will serve as the A/V equipment enclosure and as storage for the space.

a. The color is to be confirmed and coordinated with the Interiors team.
b. The standard size shall be a 1 bay, 2 bay or 3 bay credenza in width with built in front mounted 14 space rack rails, rear, and front.
c. The unit shall have recessed swivel casters, locking removable front and rear doors, ventilation fans and cable management throughout.
d. The credenza units shall be custom built (free-standing or built-in) to include audio-visual integration provided by the awarded Contractor.
e. A/V equipment and components within the credenza must be coordinated with the A/V Designer.
f. Built-in A/V credenza construction and materials shall adhere to Custom Grade requirements set forth in Architectural Woodwork Standards (latest edition).
g. The unit shall be sized for the space and coordinated with the design team.
h. Each bay minimum 24"/60.96 cm depth, 32"/61.28 cm, the standard height, but it could vary based on A/V and Interiors design requirements.

1) Concealed heavy-duty recessed swivel casters with recessed, plinth base
2) Front and rear lockable doors
3) Doors that open in opposite directions to access sliding A/V racks.
4) Provide front and back-mounted rack rails for Rack Units
5) Ventilation fans and ventilation grilles on rear doors
6) Cable management throughout
7) Metal grommets (either at the top or within the cabinet base)
8) Additional Customizations if requested by Project Designer

9) Self-pull, integrated pull, tab pull, or handle pull for ADA accommodation (color to be selected)
10) Concealed integral trash receptacle
11) Concealed refrigerator
12) Drawers
13) Raised backstop at credenza top

i. Materials and Aesthetics

1) Case Material and Doors (Drawers if specified): Wood veneer, High-Pressure Plastic Laminate, or Painted finish (must match Project Designer's specification and control sample).
2) Top Material: Custom material and edge condition per Project Designer's specification. (Glass, Solid Surface, Quartz, Solid Wood, Natural Stone, High-Pressure Plastic Laminate).
3) Recessed Base (Toe Kick) Material: Wood Veneer or Metal Finish
4) If wood veneer is selected for the case and door material, veneer direction will be provided by the Project Designer.
5) Door and cabinet thickness to be a minimum of ¾" thick.
6) Hardware used for construction of the credenza shall adhere to the requirements set forth in applicable ANSI/BHMA Standards (latest edition).
7) Concealed door hinges shall be self-closing or provided with a catch.
8) Bumper pads shall be installed at the top and bottom of each hinged door.
9) Closing stops shall be provided at the rear of drawer sides unless the drawer slides contain integral stops that prevent the drawer face from impacting the cabinet body.
10) When design permits, and if stops are not integral to the drawer slides, a mechanism shall be provided to prevent the drawer from pulling out of the cabinet.
11) Drawer slides shall provide for a minimum extension of 75 percent of the length of the drawer box beyond the cabinet body.

2. Provide power surge and suppression unit.

a. The SEQ-1U shall be a one-rack-space unit in a magnetic shielding steel enclosure. It shall operate from 120/240volts AC and have a 9-foot, grounded, 3-wire #12-line cord.
b. There shall be 6 grounded AC receptacles in three banks of two on the rear panel, each bank sequenced from the previous bank by an adjustable 0 - 40 second delay, and two receptacles always on.
c. There shall be an LCD display that shows unit status and AC line voltage, and two
d. screwdriver adjustments to program the unit.
e. Overall dimensions shall be 1.75" H x 19" W x 12.25" D. Weight shall be 13 pounds.
f. The unit shall have remote turn-on capabilities enabled by wired connections to a terminal block.
g. Remote turn-on and turn-off shall be activated by either a contact closure or applied DC voltage.

h. There shall be an output voltage source for connection to a remote LED status indicator and a relay output for control and cascading.
i. The SEQ-1U shall have a load rating of 20 amps at 120 volts, a self-test circuit with visual indicator, and provide EMI/RFI filtering, inrush current elimination, zero-cross switching, and catastrophic over/under-voltage shutdown.
j. It shall withstand at least 1000 occurrences of surge pulse voltages up to 6000 volts.

3. Provide the horizonal power distribution units (PDU) as required to support the equipment in the credenzas as required.
4. Provide a wall mounted occupancy sensor connected to the master control unit.

   a. The exact location of the device is to be coordinated with the customer and or the design team. The device can be ceiling mounted if required.

5. All exposed cabling shall be enclosed in black or color appropriate nylon sleeving.
6. All audio, video, STP, fiber and any other specialty cables shall be plenum rated to include the jumpers.
7. Provide all connectors, cables, adapters, plates, panels, and power supplies as necessary to provide a complete and operating system as outlined in these documents and as drawn in the TA-series drawing package.

2.2 PRODUCTS/GENERAL

A. Near Field Communication Technologies (e.g., Bluetooth) if provided shall have the option to be turned off by end user and shall be installed within the GWA only.

B. Control Systems

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Crestron Electronics, Inc.
   b. Extron
   c. Utelogy

2. Large System Controller:

   a. Control system shall be fully compatible with room management software and third-party applications (e.g., e-Outlook, e-PowerPoint).
   b. Network Connections:
   c. Control system shall support 10/100/1000 BaseT Ethernet LAN.
   d. Add-on 10/100/1000 BaseT Ethernet Modules.
   e. TCP/IP communications.
   f. DHCP and DNS support.
   g. Native email client.

h. Remote diagnostics.
i. Remote program loading and administration.
j. Built-in web server.

3. Control system shall include the following hardware configuration:

a. Eight IR/serial/one-way RS-232 ports.
b. Eight digital/analog I/O ports – TTL In/Out & analog inputs 0 10V.
c. Eight isolated low-voltage relays – 30VDC @1A.
d. Six 2-way RS-232/422/485 ports.
e. Proprietary control port.
f. One compact flash memory upgrade slot.
g. Front and rear programming ports.
h. Internal power supply.
i. Front and rear programming ports.
j. Control system shall support optional add-on of control cards such as IR, RS-232/422/485, relay, digital I/O, analog input, volume, MIDI.
k. Chassis: 475 mm (19 inch) rack-mounted or shelf-mounted (removable rack ears).

4. Large-Wired Touch Panel:

a. Integrated unit.
b. Minimum Resolution: 800 by 600 pixels.
c. Panel Size: 256 mm (10.1 inch) minimum (diagonal).
d. Support graphic animation on a variety of object styles.

C. Displays

1. Large-Venue Video Projectors:

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Barco
2) Christie Digital Systems
3) Digital Projection Inc
4) Panasonic
5) Sony

b. Display Properties:

1) Resolution: Native UHD 4K (3840 x 2160) minimum.
2) Display Engine: Three-chip DLP, Laser and Laser RGB, three-element LCD or LCOS (liquid crystal on silicon).
3) SD/HD/UHD Video Signal Compatibility: 2160p/2160i, 1080p/1080i, 720p.

4) PC Signal Compatibility: WXGA, WXGA+, WSXGA, SXGA+, WUXGA (1920 x 1200), 4K UHD.
5) Brightness: ≥12,500 ANSI lumens, minimum.
6) Contrast Ratio: 2000:1.
7) Lens Shift: Vertical and horizontal.
8) Start-Up Screen: Programmable with menu mute/suppress and blue screen off settings, image adjusting/warping software available and included as necessary.
9) Power Supply: AC100-240V.
10) Noise: 50dBA maximum.
11) Inputs - Typical:
12) Control Terminals: Ethernet, RS232, USB.
13) System management and control via Ethernet LAN – TCP/IP (RJ-45 jack).
14) HDMI with HDCP and EDID.
15) Display Port
16) HDBase-T

c. Lens:

1) Size focal length so lens is zoomed no further than ± 20 percent from center focal length.
2) Interchangeable.
3) Powered focus.
4) Horizontal and vertical lens shift.

d. Accessories:

1) Power cord.
2) Wireless remote control.
3) Mounting/rigging cage and mounting hardware, eyebolts, and other attachment devices to interface with rigging grid or motorized lift system.

2. Flat-Panel Displays:

a. The displays shall have no Bluetooth, RF or other wireless interface method installed in the device. The display shall be a commercial series not a consumer series.
b. The designer shall ensure the display is appropriate for the mission task.
c. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Christie
2) LG Electronics
3) NEC/Sharp
4) Sony
5) Samsung

d. Operation: 16/7 minimum.
e. Display Viewable Image Sizes:

1) Lobby or information display: 1397-1651mm (55 to 65 inches).
2) Small display:1651 to 1750 mm (65 to 70 inches).
3) Medium display: 1750 to 2184 mm (70 to 86 inches).
4) Large display: 2184 to 2667mm (86 to 105 inches)

f. Video Properties:

1) Colors: 16.7 million minimum.
2) Native Resolution: Minimum 3840 x 2160 at 50/60Hz (analog/digital).
3) Maximum Digital: 2560 x 1600 at 60Hz.
4) Display Response Time: Eight-milliseconds.
5) Brightness: 350 cd/m2 (typical)

g. Display Properties:

1) Closed-caption decoder.
2) Minimum Viewing Angle: 177 deg horizontal, 177 deg vertical.
3) Anti-glare, anti-reflective screen treatment.
4) Operating temperature: 0 to 40 deg C (32 to 95 deg F).
5) Operating Humidity: 10 to 80 percent, non-condensing.
6) Power-save mode.
7) Power timer.
8) Internal power supply.
9) Power Characteristics: 100V - 240V AC, 50-60Hz.
10) System management and control via Ethernet LAN.
11) Audio Power: 20W (10W x 2) minimum.

h. Supported Formats:

1) HDTV Formats: 4K minimum.
2) NTSC, NTSC4.43.
3) SECAM.
4) PAL, PAL60, PAL-M, PAL-N.
5) VESA type graphics, up to 1920x1200 (WUXGA) minimum.

i. Digital Video Inputs:

1) HDMI.
2) HDCP2.2 compliant.
3) Version (v) 2.0 compliant minimum. Contractor shall provide and use the latest version at the time of purchase.
4) Display Port.
5) USB 2.0 (provide and use the latest version available at time of purchase.

j. Audio Inputs:

1) Stereo mini jack
2) HDMI
3) Audio (common)

k. Control Inputs:

1) Ethernet/TCP-IP (RJ-45).
2) RS232 control.
3) Infrared (IR).
4) Other inputs: USB 2.0

l. Accessories:

1) Setup/operation manual.
2) Power cord.
3) Wireless remote control.
4) Remote mouse receiver with batteries.

m. Certifications:

1) Energy Star

D. Mounting Devices:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Chief Manufacturing.
b. Omni Mount.
c. Peerless Industries, Inc.
d. Premier Audio Visual.

2. Projector Mounts:

a. Ceiling Mount:

1) Roll: +/- 3 degrees.
2) Pitch: +/- 20 degrees.
3) Yaw: 360 degrees.
4) Weight Capacity: 11 kg (25 lbs).

b. Security Mount:

1) Roll: +/- 4 degrees.

2) Pitch: +/- 25 degrees.
3) Yaw: 360 degrees.
4) Weight Capacity: 23 kg (50 lbs).

c. Short Throw Mount: Short throw single-stud wall arm.

1) Extension: 0 to 450 mm (0 to 18 inches).
2) Pitch: +/- 3 degrees.
3) Weight Capacity: 23 kg (50 lbs).

3. Flat Panel and Touchscreen Mounts:

a. Full-Swing Wall Mounts, dual-swing arm, 1390 mm to 1775 mm (55 inch to 71 inch) display:

1) Maximum extension: 925 mm (37 inches).
2) Tilt: + 5 degrees to -17 degrees.
3) Roll: +/- 2.5 degrees.
4) Swivel: 90 degrees.
5) Weight Capacity: 90 kg (200 lbs.).

b. Tilt Wall Mounts, 1675 to 2560 mm (55 to 98 inch) board/panel:

1) Depth from wall: 51 – 8.1cm (2 - 3.2 inches).
2) Weight Capacity: 34-115 kg (75 -250 lbs.).
3) Literal shift: 265 mm (10.4”).
4) Tilt: +2-5°
5) Certifications: OSHPD, TAA, TUV, UL Listed

c. Extra Large Pull Out Accessory, 2184 to 2667 mm (86 to 105 inch) panels:

1) Wall mounted unit, with up to three attachment devices.
2) The pull out accessory would attach to the tilt mount on the display.
3) The pull accessory allows the display to be extended 293 mm (11.54 inches) from the wall, for service.

E. Video Systems:

1. Extender Units

a. The extender units shall be a standard based product using STP cabling.
b. The extender deployed shall be of the same manufacturer, Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) ZeeVee
2) Crestron

3) Extron

c. Provide a 4K transmitter extender over STP with the following features:

1) Transmits DisplayPort (DP), HDMI, control and analog audio up to 330 feet (100 meters) over a shielded CATx cable.
2) Inputs: one HDMI or one DP, one 3.5 mm stereo mini jack for audio.
3) One STP transmitter output.
4) Supports computer and video resolutions up to 4K/60 @ 4:4:4.
5) Analog stereo audio embedding.
6) Supports HDMI 2.0b - data rates up to 18 Gbps, High Dynamic Range (HDR), Deep Color up to 12-bit, 3D, and HD lossless audio formats.
7) Supports DisplayPort Single Stream Transport (SST) data rates up to 21.6 Gbps.
8) Support for HDR video.
9) Remote power capability.
10) 24 shielded twisted pair is recommended for optimal performance
11) Output is compatible with High Definition Base T (HDBaseT) -enabled devices — The STP output can be configured to send video and embedded audio, plus bidirectional RS 232, and IR signals to an HDBaseT-enabled display.

d. A 4K receiver extender over STP with the following features:

1) Receives HDMI plus control and analog audio up to 330 feet (100 meters) over a shielded CATx cable.
2) Input: One twisted pair input on RJ-45
3) Outputs: One HDMI, stereo audio on captive screw.
4) Supports computer and video resolutions up to 4K/60 @ 4:4:4.
5) Supported HDMI 2.0b specification features include data rates up to 18 Gbps, HDR, Deep Color up to 12-bit, 3D, HD lossless audio formats, and CEC pass-through
6) Support for HDR
7) HDCP 2.3 compliant
8) Remote power capability
9) Bidirectional RS 232 and IR pass-through for AV device control.
10) Supports EDID and HDCP transmission.
11) 1” (2.5 cm) high, quarter rack width metal enclosure.

2. 10x8 scaling presentation matrix switcher to support the switching requirements, the unit shall have the following features:

a. Provide six HDMI video input connections.
b. Four RJ-45 for video from STP twisted pair transmitters.
c. Support 4K and UHD signals at all inputs.
d. Provide image adjustments for the STP outputs, including brightness, contrast, color, tint, detail, H/V positioning, and sizing.

e. Automatic memories for each video input.
f. User presets may be saved and recalled electronically via Ethernet, RS-232, or USB connection.
g. Support HDMI specifications including data rates up to 10.2 Gbps, Deep Color up to 12-bit, 3D, and HD lossless audio formats.
h. Provides automatic cable equalization for each digital input to 100 feet (30 meters) at 1080p/60 with 8-bit color.
i. Provide automatic cable equalization for each digital input to 50 feet (15 meters) at 4K/30 and 2560x1600 @ 60 Hz resolutions.
j. Support video transmission over shielded CATx up to 330 feet (100 meters).
k. Video output connections six HDMI.
l. Two dedicated RJ-45 for video to STP twisted pair receivers.
m. Shall support up to 16 logo presets.

3. A/V network managed switch for the display control, audio, and other tasks.

a. The switch shall be deployed in the equipment enclosure.
b. The switch is detailed on the budget sheet.
c. The switcher shall support:
d. Network ports 24 10/100/1000 Ethernet copper ports
e. Network ports 2 10G SFP+ ports uplinks
f. POE+ power on 24 ports
g. The unit shall be provided with a three-year maintenance support contract to minimize any down time.

4. Provide a modular, configurable, and furniture-mountable enclosures that shall support a combination of AC power modules, A/V cables, and other plates, the unit shall be configured with:

a. shall have the following features:

1) The device shall include modules and mounting frames to support AC or AC-plus-USB power, A/V cables and/or A/V connectivity plates.
2) AC power modules shall be UL listed and CE compliant when installed within the enclosure. AC power modules shall include an attached AC power cord or IEC power inlet with detachable AC power cord, as required by local electrical power codes and conventions.
3) Device shall include an attached and fully integrated, all metal lid and bezel assembly.
4) The lid and bezel assembly shall be available in a black anodized or brushed aluminum finish, the finish shall be black as a default unless directed by the customer.
5) Device lid shall fit entirely within the bezel, when closed, the lid shall provide a full width opening for cable pass-through. When open, the lid shall articulate such that it fits within the enclosure body. Device shall include a damper that controls the speed of the lid as it moves within the enclosure.

6) The enclosure shall feature an integrated clamp system, the clamps shall be permanently affixed to the enclosure body. The clamps shall utilize a lever-and-cam mechanism.

b. Devices to be installed inside of the modular table box.

1) Provide one - AC-plus-USB power modules, the module shall provide two outlets AC and two USBA charging ports in a single module.
2) USB power outlets shall provide 5 volts Direct Current and up to 2.1 amps, or 10.5 watts of power.
3) Provide one HDMI female to female with a 10” pigtail on a single space plate, to be installed in the table box.
4) Provide one DP to DP with a 10” pigtail on a single space plate, to be installed in the table box.
5) Provide one RJ45 CATX punch down connector plate, to be installed in the table box for CUI connection.
6) The table connections will connect to a switcher/transmitter unit.

5. Cameras:

a. Available manufacturers:

1) Cisco
2) Poly
3) Sony
4) Vaddio

b. Certifications/Compatibility:

1) Compatible with current collaboration systems, Team, Poly, Webex

c. Camera extension units:

1) Sound Control
2) Vaddio

d. Pan and Tilt:

1) Pan: +/- 100 degrees
2) Tilt: +/- 20 degrees

e. Resolution: 1920 x 1080 at 60 fps minimum.
f. Zoom:

1) Optical: 10x
2) Digital: 2x
3) Total: 20 x

g. Field of View:

1) Horizontal: 80
2) Vertical: 48.8

h. Camera Control: Ethernet, RJ45
i. Focus: 1 meter to infinity.
j. Video Interface: HDMI, 3G-SDI
k. Network Interface: RJ45
l. Operating Temperature: 0 to 40 degrees C, ambient temperature, 10 to 90 percent relative humidity.
m. Storage/Transport Temperature: -20° to 60°C (-4° to 140°F) at RH 10% to 90% (noncondensing).

6. All-In-One Videoconferencing Bar

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) HP/Poly
2) Logitech

b. Minimum Features:

1) Integrated camera, stereo speakers, and microphones
2) 1920x1080 @ 30fps camera resolution
3) Wide angle horizontal field of view
4) Onboard AEC (Acoustic Echo Cancellation)
5) USB connectivity to PC/MAC
6) Teams and Zoom certified

7. Multi-Format Disk Player:

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Sony
2) Samsung
3) Panasonic

b. HDMI video output with multichannel audio stream (HDMI or SPDIF).
c. 4K output resolution.
d. Play video and images (jpg, jpeg, gif, png, and other common formats).
e. Memory card slot for standard SD memory card, compact flash, memory stick, multimedia card, and smart media.

f. Blu-Ray, DVD video, DVD-RAM, DVD-R, DVR-R/RW, audio CD, video CD, MP3, and MP4.

8. Collaboration Solutions:

a. A collaboration system uses software and technology to enable team members to communicate and share documents in a digital space. The purpose is to use collaboration systems to solve work-related problems such as chaotic communication, paper-heavy processes, or inability to offer workers telecommuting opportunities.
b. The systems range from desktop, laptop and room based systems, which can be deployed as required to support the mission.
c. The room-based systems have two major types:

1) Small/Medium room – all-in-one, (bar/camera under the display)
2) Larger rooms – codec hardware, camera units, microphones (ceiling and table).

F. Audio Systems:

1. Digital Signal Processors

a. Available manufactures, subject to compliance with requirements, manufacturers offering the products that may be incorporated into the work include, but not limited to the following:

1) Biamp Systems
2) QSC

2. Minimum functions:

a. Programmable and configurable to allow changes in system functions, features and control.
b. Digital Audio or other multi-channel digital buss option via F/UTP cable.
c. System management and control via Ethernet LAN.
d. The combination of inputs and outputs as required to support the design
e. Routing and mixing of audio signals.
f. Dynamic and spectral processing of audio signals.
g. Automatic echo canceling for conferencing
h. Automatic feedback eliminator.
i. Phantom power.
j. Provide 40 percent input/output spare capacity.

2.3 DIGITAL AUDIO NETWORKS:

A. Digital Audio Network can be hardware or software based, either as a standalone conversation unit or embedded in products

1. The digital network units shall support lossless audio 24-32 bit, with sample rates from 44.1 kHz to 192 kHz.
2. The digital network shall have the option of a control management software which could if deployed manage all of the devices remotely within a facility.
3. The devices shall be able to input an analog audio signal and output the digital format in a network protocol, this also applies for the reverse processing, the digital to analog conversation process.
4. The audio is packetized into a segments and wrapped in an Internet Protocol (IP), which allows it to be transported across a network using standard network equipment.
5. The devices may support multiple Input/Output (I/O)'s on or in a single device.
6. Digital Audio Network software and hardware is used across multiple platforms, audio, video and control, the devices should be installed as required to support the mission.

B. Digital Audio Console:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Yamaha.
   b. Allen Heath

2. Minimum functions:

   a. Minimum of 24 bit internal processing.
   b. Minimum of 44.1 KHz sampling frequency (internal/external clock).
   c. Minimum of eight balanced audio inputs.
   d. Stereo monitor, phones, aux outputs.
   e. Digital stereo output.
   f. Minimum of eight-track playback at 24 bit.
   g. Eight-bus master section.
   h. USB 2.0 connection.
   i. Digital Audio connections

C. Assisted Listening System:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Listen Technologies

2. Minimum Features:
3. Digital IR language Delivery system
4. A digital congress main station
5. 4 channel digital IR transmitter
6. 4 channel Digital IR Receiver unit, belt pack
7. Headphones for the belt pack receiver with sponge cover
8. Sponge ear pads - spare
9. Recharge batteries for belt packs, with charging cases
10. Fully Digital Congress Interpreter Unit, for 2 interpreters
11. Digital IR Radiator 25W, with wall mount
12. Digital conference master.
13. Interpreter set.
14. Gooseneck microphone for interpreter set.
15. Delegate microphone with fixed microphone and channel selector.
16. Audio output unit.
17. Conference management software.
18. Dual headphone.
19. Ear bud headphone option.
20. Inductive neck loop.
21. Coordinate signage with project signage for style and use dual language (including local language(s)); refer to project Construction Documents.

D. Power Amplifiers

1. Power amplifiers selection is based upon the required wattage required to support the design for each type of system. The unit if required to interface with other system components, it should have a Digital Audio Interface. The proper unit shall be utilized to support the following system allowing for 20 percent headroom above typical loads:

   a. Playback
   b. Voice Reinforcement
   c. Background or other informational systems.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. QSC Audio.
   b. Ashly Audio.
   c. Lab.gruppen.
   d. Crown
   e. Crestron
   f. Extron.
   g. Biamp

3. Power amplifiers selection in the Construction Documents is based in part on load per channel. The Contractor may utilize different power amplifier configurations that meet the per channel requirements.

E. Loudspeakers.

1. Ceiling Loudspeaker:

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in to the Work include, but are not limited to, the following:

1) Tannoy
2) Biamp
3) JBL by Harmon.
4) QSC
5) Crestron
6) Extron
7) Atlas Sound.

2. Program/Playback Loudspeaker:
3. Program speakers for flat panels:

a. The speakers shall match the height of the display.
b. The speakers shall mount to the bracket on the back of the display.

4. Wall mounted speakers:

a. The speakers shall be secured to the wall with safety cables.
b. The units shall be color coordinated to match the room environment as close as possible.
c. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Tannoy
2) Leon
3) JBL by Harmon
4) Turbosound.
5) Atlas Sound.

d. Accessories.

1) Yoke or ball-and-socket mount.
2) Refer to mounting details for custom brackets.

e. Mounting brackets with attach to the display

F. Microphones and Accessories:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Beyerdynamic.
   b. Shure, Inc.
   c. Sennheiser.
   d. Clock Audio
   e. Biamp
   f. Audio-Technica

2. Lectern/Table-Mounted Gooseneck Cardioid Microphone:

   a. Cardioid pattern, condenser/capacitor element.
   b. Phantom power, 48 VDC.
   c. Mute switch (logic type) with separate output contact and LED indicator (red = mute, green = active or 'on').
   d. LED Color ring for status with Logic control.
   e. Digital audio interface if required per design.
   f. Shock mount base permanently mounted in lectern or table.

2.4 DIGITAL VIDEO TRANSMISSION SPECIALIZED ACTIVE CABLING:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in to the Work include, but are not limited to, the following active cabling:

   1. Rapid Run.
   2. Hubble Premise Wiring.
   3. Video input (wall plate) and output (flying lead) signal properties:
   4. video.
   5. HDMI or DP

B. Maximum transmission distances passive: 10 meters.

C. Maximum transmission distances active: 30 meters.

D. Video Capture:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in to the Work include, but are not limited to, the following:

   a. Vaddio

b. Epiphan Video

2. HDMI, SDI, DisplayPort, video inputs.
3. 3840 x 2160 minimum resolution.
4. Digital and Analog Audio Inputs: IEEE 1394, XLR balanced stereo, RCA unbalanced stereo.
5. Webcast live/record on demand.
6. Simultaneous video, graphics, and audio capture.
7. 56 Kbps to 2 Mbps encoding.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Refer to Section 274100 “Integrated Audiovisual Systems General Requirements” for general installation requirements.

3.2 CONTRACTOR’S FINAL CHECKOUT

A. Refer to Section 274100 “Audiovisual Systems General Requirements.”

END OF SECTION 274114

SECTION 274117 – PROJECTION SCREENS AND PROJECTOR LIFTS

GENERAL

1.1 SUMMARY

A. This Section the following video equipment: Note: The projection screen should only be deployed if the display requirement is over 105”/2667mm.

1. Front projection screens.
2. Motorized projector lifts.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
2. Section 270508 “Common Work Results for Telecommunications.
3. Section 274100 “Audiovisual Systems General Requirements.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to these references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

B. American National Standards Institute / Audiovisual and Integrated Experience Association (ANSI/AVIXA (formerly INFOCOMM))

1. ANSI/AVIXA V201.01:2021: Image System Contrast Ratio

C. Society of Motion Picture and Television Engineers (SMPTE):

1. SMPTE RP 94-2000 - Gain Determination of Front-Projection Screens

1.3 DEFINITIONS

A. Projection-Surface Gain: Indication of screen's luminance or brightness that is measured perpendicular of screen center and measured relative to block of magnesium carbonate, which serves as standard for 1.0 gain. Higher numbers indicate greater brightness. Gain shall be determined in accordance with SMPTE RP 94.

B. Projection-Surface Viewing Angle: Angle from perpendicular center of screen, where gain or brightness is decreased by 50 percent.

C. Keystone: Distortion of projected image when screen is not perpendicular with center line of projected image.

1.4 SUBMITTALS

A. General: Technical submittals (e.g., product data, shop drawings, schedules) associated with all Division 27 A/V Specifications shall be submitted together with the submittals for this Section to facilitate coordination of systems.

B. The submittal package shall include all documents that support the A/V design and installation at the minimum but not limited to the following if applicable:

1. Drawings – build to details
2. IP Information Sheet (which is a living document)
3. Data product sheets
4. Room and Equipment detail sheets
5. Cable Runs sheets
6. Finish Schedules for furniture:
7. Spare parts list

C. The submittals shall be submitted in a PFD format.

1. The PFD documents shall be searchable.
2. The PDF documents shall utilize bookmarks for all major sections, and details within the sections, this is to facilitate quick switching between rooms and or other areas within the document.
3. The first page of each manufacturer’s PDF shall be bookmarked.

   a. Within the manufacturer’s PDF, the equipment relative to the project shall be highlighted or emphasized in a manner for quick reference.

4. Excessive pages from manufacturers with no relation to project should be removed to reduce the size of the PDF document.

D. Product Data:

1. Manufacturer’s product data sheets for all materials and equipment, sorted by room and indexed.
2. Manufacturer's product data sheets for all associated fire-stopping materials.
3. Manufacturer’s product data sheets for accessories, including technical panels, escutcheons, and trim components. Include fasteners and supports.

E. Shop Drawings: Submit the following A/V shop drawings and details, they shall be submitted as a separate package from any other drawings:

1. Detailed drawings shall include all of the areas which will receive any Audiovisual solution. The drawing set shall include at a minimum the following for each area if applicable:

a. An enlarged plan view for the facility requirements
b. An enlarged plan view for the infrastructure requirements:

1) A/V network drop
2) A/V back boxes
3) A/V conduit sizes and locations
4) Cable tray and pathways
5) Equipment rack locations for A/V and any other rack to support Telecommunications or other signals.
6) Electrical connections locations

c. An elevation drawing for each A/V solution.

1) Which includes but is not limited to:

a) Projector Screen
b) Projector Lift
c) A/V network drops “**”AFF
d) A/V conduit sizes and locations
e) Any other devices locations “**”AFF

2) Consistent with Construction Drawings, detail installation of equipment and cable layout to further enhance operational efficiency and overall aesthetic factors.

d. System-riser diagrams for each area with Audiovisual components.
e. System flow drawings with detailed wiring diagram input/output connections for each piece of equipment, interconnects, data flow, and other pertinent information.
f. Wiring diagrams for each A/V subsystem that define interconnection of all inputs and outputs for all equipment.
g. Fabrication shop drawings for all custom equipment, as applicable.

F. Cable run sheets (e.g., diagrams or spreadsheets) that denote cable type, signal type, termination type, cable number designation, start point, and end point.

G. Finish Schedules for furniture:

1. List of finishes and sample graphics, including custom artwork and custom graphics per device, if applicable.

H. Spare Parts List: List of parts inventory to reflect manufacturer recommended service and maintenance of the work.

I. Samples:

1. Case, enclosure, and closure finishes for selection by Project Director/COR with input from OBO/PDCS/DE/AD.
2. Viewing surface material: 150 by 150 mm minimum size.

J. Manufacturer's installation instructions.

K. Operations and Maintenance Data: Include manufacturer's operation, maintenance, and cleaning instructions.

L. Field Quality Control Report.

1. Prepare spreadsheet-type of report documenting results of device checkout. List every device and circuit by function.

1.5 QUALITY ASSURANCE

A. Manufacturer qualifications: Firm with five years minimum of successful experience manufacturing electric projection screens and/or lifts.

B. Motors for electric screens and lifts shall be certified by Underwriters Laboratory (UL), Inc. and shall bear UL label.

C. Screens and lifts recessed and installed in return air ceiling plenums shall be certified by Underwriters Laboratory (UL), Inc. and shall bear UL label.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver projection-screen cases, frames, lift enclosures, and lifts to project site after building is enclosed and construction in rooms where devices will be installed is substantially complete.

B. Screen rollers and surface material shall be stored in protected “clean conditions” until ready for installation.

C. Deliver screens in manufacturer's undamaged, labeled packaging.

PART 2 - PRODUCTS

2.1 GENERAL ELECTRICAL REQUIREMENTS

A. Motors: 120 Volt 60 Hz; or 240 Volt, 50 Hz, Single-Phase fully insulated and grounded three-wire.

1. Equip with noise silencer, automatic thermal overload protection, integral gears, capacitor, and electric brake to prevent coasting.

B. Limit Switches: Pre-set, adjustable switches to automatically stop viewing surface or case closure door (as applicable) in up or down positions.

C. Low Voltage Controllers: 12-24 V DC contact closure, mounted to or within case. Provide low-voltage three-button Decora-style switch with single-gang cover plate.

2.2 MOTORIZED ELECTRIC PROJECTION SCREENS – RECESSED CEILING MOUNTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to the following:

1. Da-Lite.
2. Stewart Filmscreen.
3. Draper, Inc.

B. Configuration as indicated on Construction Drawings.

C. Assembly: Motorized projections screen shall be complete and include case, roller/motor assembly, screen material, low-voltage controller, and switch.

D. Screen Materials:

1. Matte White: Flame-retardant, mildew-resistant, vinyl screen that can be rolled and can be cleaned with mild soap-and-water solution. Provide screen material with opaque black backing. Screen surface shall be unity-gain matte white and have black masking border.

a. Gain: 1.0.
b. Viewing Angle: 50 degrees.
c. Screen Aspect Ratio: 16:9 (1.778:1).

2. High-Gain White: Flame-retardant, mildew-resistant, vinyl screen that can be rolled, and can be cleaned with mild soap-and-water solution. Provide screen material with opaque black backing. Screen surface shall be high-gain pearlescent white and have black masking border.

a. Gain: 1.5.
b. Viewing Angle: 35 degrees.
c. Screen Aspect Ratio: 16:9 (1.778:1).

E. Housing and Finish:

1. House screen in extruded aluminum or formed sheet-steel case, ceiling-recessed, with end-bracket flanges for mounting on threaded rods.
2. Case: Plenum rated.
3. Screen Roller: Electrically operated, permanently mounted screen material.
4. Screen Finish: White or matte-black power coat in accordance with Construction Documents, or if not addressed there, as selected by Project Director/COR.

F. Screen Tensioning System: Adjustable tab-guide cable system to maintain even lateral tension and to hold viewing surface flat.

2.3 MOTORIZED, ELECTRIC PROJECTION SCREENS – SURFACE MOUNTS

A. Available Manufacturers. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to the following:

1. Da-Lite.
2. Stewart Filmscreen.
3. Draper, Inc.

B. Configuration as indicated on Construction Drawings.

C. Assembly: Motorized projection screens shall be complete and include case, roller/motor assembly, screen material, low-voltage controller, and switch. Provide screens with mounting brackets and hardware to allow mounting to vertical surfaces, rigid and suspended ceiling types.

D. Screen Materials:

1. Matte White: Flame-retardant, mildew-resistant, vinyl screen that can be rolled, and can be cleaned with mild soap-and-water solution. Provide screen material provided with opaque black backing. Screen surface shall be unity-gain matte white and have black masking border.

a. Gain: 1.0.
b. Viewing Angle: 50 degrees.
c. Screen Aspect Ratio: 16:9 (1.778:1).

2. High-Gain White: Flame-retardant, mildew-resistant, vinyl screen that can be rolled, and can be cleaned with mild soap-and-water solution. Provide screen material with opaque black backing. Screen surface shall be high-gain pearlescent white and have black masking border.

a. Gain: 1.5.
b. Viewing Angle: 35 degrees.
c. Screen Aspect Ratio: 16:9 (1.778:1).

E. Housing and Finish:

1. House screen in extruded aluminum or formed and rounded sheet-steel case.
2. Screen Roller: Electrically operated, permanently mounted screen material.
3. Screen Finish: White or matte-black power coat in accordance with Construction Documents, or if not addressed there, as selected by Project Director/COR.

F. Screen Tensioning System: Adjustable, tab-guide cable system to maintain even lateral tension and to hold viewing surface flat.

2.4 FIXED-PROJECTION SCREENS – SURFACE MOUNTS

A. Available Manufacturers. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Da-Lite.
2. Stewart Filmscreen.
3. Draper, Inc.

B. Configuration as indicated on Construction Drawings.

C. Type: Permanently tensioned projection screens fabricated by attaching viewing surface taut to perimeter frame for permanent wall installation.

D. Frame: Fabricated from 38-mm-square aluminum tube and equipped with snaps at 150 mm on center.

E. Provide L-shaped, wall-mounting brackets and frame projects 57 mm from wall.

F. Construction: Reinforce viewing surface with black webbing on four sides and snaps to fit base frame. Wrap viewing surface around to conceal frame and attach to rear side. Conceal webbing behind frame.

G. Screen Materials:

1. Matte White: Flame-retardant, mildew-resistant, vinyl screen that can be rolled, and can be cleaned with mild soap-and-water solution. Provide screen material with opaque black backing. Screen surface shall be unity-gain matte white and have black masking border.

a. Gain: 1.0.
b. Viewing Angle: 50 degrees.
c. Screen Aspect Ratio: 16:9 (1.778:1).

2. High-Gain White: Flame-retardant, mildew-resistant, vinyl screen that can be rolled, and can be cleaned with mild soap and water solution. Provide screen material with opaque black backing. Screen surface shall be high-gain pearlescent white and have black masking border.

   a. Gain: 1.5.
   b. Viewing Angle: 35 degrees.
   c. Screen Aspect Ratio: 16:9 (1.778:1).

2.5 MOTORIZED PROJECTOR LIFTS

A. Available Manufacturers. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. SVS Lifts.
   2. Display Devices.
   3. rp Visual Solutions.
   4. Audipack Verkoop B.V.

B. Configuration as indicated on Construction Drawings.

C. Assembly: Complete and include frame, enclosure, closure, roller/motor/scissors assembly, mount, low-voltage controller, and switch. Lift-lowering mechanism shall include wire way for management and protection of cables feeding down to projector. Provide lift with mounting brackets and hardware to allow mounting to deck above, to allow trim and closure materials to match, and to allow flush mounting in rigid and suspended ceiling types.

D. Screen Materials:

   1. Lifts for Large Projectors (Greater than 12,000 Lumen):

      a. Maximum weight capacity of up to 300 kilograms.
      b. Maximum lowering distance of 6850 millimeters (sized to allow projector to lower to within 1200 mm).
      c. Provide three positions, with adjustable, field programmable limits for the following positions:

         1) Storage: Flush in ceiling.
         2) Show: Projector in use.
         3) Service: Lowered to allow maintenance at maximum of 1200 mm AFF.

   2. Lifts for Small and Mid-Sized Projectors (Less than 12,000 Lumen):

      a. Maximum weight capacity of up to 180 kg.
      b. Maximum lowering distance of 3000 mm.

c. Provide three positions, with adjustable, field programmable limits for the following positions:

1) Storage: Flush in ceiling.
2) Show: Projector in use.
3) Service: Lowered to allow maintenance at maximum of 1200 mm AFF.

E. Housing and Finish:

1. House lift sheet-metal enclosure shall match lift size and model.
2. Enclosure Finish: Matte black to obscure view of interior.

F. Closure Panel:

1. Ceiling closure shall include outside and inside trim, Closure trim and support shall include fine adjustment to ensure flush appearance with surrounding trim and ceiling. Closure panel and trim shall be of type and finish in accordance with Construction Documents, or if not addressed there, as selected by Project Director/COR.as approved by the architect and consultant.

G. Lift shall have mechanism that locks lowering drum in position when lift is in position.

H. Lift shall maintain projector in stable, fixed position when in use, with negligible lateral movement or “sway.” Lift shall be rated for installation in seismic environments where applicable to location.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installation of screen rollers and material rear-projection screen substrates shall not take place until spaces where devices will be installed are substantially complete and determined by Project Director/COR to be under “clean condition.”

3.2 INSTALLATION

A. Mounting Heights:

1. Coordinate the locations of screens and lifts with Construction Drawings and schedules.
2. Coordinate locations and mounting heights of junction boxes and outlet boxes, specified in Division 26 Section, with Construction Drawings.

B. Install all screens, screen enclosures and frames and lifts plumb.

C. For recessed front projection screens, coordinate:

1. Screen size.
2. Mounted depth.
3. Required edge tolerances with construction of wall recesses to house screens.
4. Requirements for blocking and structural supports to ensure adequate installation of screens.

D. Install in manner to facilitate adequate ventilation and maintenance access. Install electric screens and lifts to allow access to motors and control interface units.

3.3 PROJECTOR LIFT CABLING

A. Train and lace cables in a workman-like manner.

B. Provide service loops for each cable and cable bundle at each termination endpoint within lift enclosure and at projector. Install cable lengths sufficient to allow projector to be lowered to service position, while maintaining service loops and bend radii.

C. Secure cables within lift cable management devices. Install cables in manner that bend radium limits are not exceeded and cabling is protected from damage by lift scissors mechanisms.

D. Terminate cabling within lift enclosure with common connectivity to allow easy replacement of lift cabling without need to pull new cabling through ceiling space or ceiling raceway.

3.4 CABLE SEPARATION

A. Maintain separation of cable groups for runs greater than 7.5 meters.

B. Maintain separation of 300 millimeters from AC circuits.

3.5 WIRE TERMINATION

A. Acceptable wire termination means include the following:

1. Solder connections: For connectors utilizing solder cups.
2. Terminal-strip connectors: For termination of blunt cut cables, tin cable prior to termination.
3. Multi-pin connectors: Utilize connector manufacturer’s crimper.
4. Crimp cap terminations: Utilize the correct sized fork spade connector; part of the connector shall not be cut off or bent.
5. Strip terminations for signal extension: Utilize the correct sized fork spade connector; part of the connector shall not be cut off or bent.

3.6 FIELD QUALITY CONTROL

A. Contractor shall perform the following quality control activities prior to:

1. Devices are secured to structure, free from lateral movement and sway, and are supported as required by Code.
2. Motorized device limits are set for up/storage, down/show and service and stop positions (as applicable).
3. Tab tensioning cables are set in accordance with manufacturer instructions and as appropriate for screen drop.
4. Low-voltage interfaces are installed and integrated with controllers/control systems.
5. Screens and screen frames are installed level and plumb, are trimmed, and are free of scratches, blemishes and are cleaned.
6. Connections are tight, correctly soldered and correctly crimped.
7. Required labels are correct and in place.
8. Dust and construction debris have been removed from facility and from inside of enclosures.
9. Electronic devices have been correctly grounded.
10. Prior to energizing any electronic devices, test each and every AC circuit associated with systems with voltmeter and circuit checker to assure that voltage is correct and that hot, neutral, and ground conductors have been correctly connected.

3.7 SYSTEM ACCEPTANCE

A. Refer to Section 274100 “Audiovisual Systems General Requirements” for system acceptance of overall audiovisual system.

B. Contractor shall have copy of Field Quality Control Report available on site at time of USG representative system acceptance. See Articles on SUBMITTALS and on FIELD QUALITY REPORT.

END OF SECTION 274117

SECTION 275105 – AUDIO SYSTEMS FOR CONSULAR SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes audio communications systems for consular services, including intercommunications systems for consular teller window stations, and paging system for general consular waiting area and associated waiting area outside of building.

B. Related Sections:

1. Division 26 Section on raceways and boxes for conduit installed outside of building.
2. Section 270526 “Grounding and Bonding for Communications Systems.”
3. Section 275124 “General-Use Teller Window Intercommunications Systems” for teller window intercommunications at locations not associated with Consular Waiting Area. Those intercoms are not related to the work of this Section.
4. Section 275405 “Consular Queue Management System Infrastructure and Displays” for interfacing queue management system.
5. Other Division 26 and Division 27 sections for conduits, wire ways, connection boxes, pull boxes, junction boxes, electrical breaker panels required to power audiovisual systems, and outlet boxes permanently installed in walls, floors, and ceilings.

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to these references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

B. American National Standards Institute/ Audiovisual and Integrated Experience Association (ANSI/AVIXA (formerly INFOCOMM)):

1. ANSI/AVIXA: A102.1:2022 "Measurement and Classification of Audio Coverage Uniformity in Listener Areas"
2. ANSI/AVIXA: D104.01:2023 "Documentation Requirements for Audiovisual Systems"

1.3 FUNCTIONAL DESCRIPTION OF SYSTEM

A. General:

1. The intent is to provide a fully operational system with voice amplification to facilitate communication by both teller and applicant at each Consular Teller Window without requiring each to raise their voices, and to provide a clear audio experience of paging system for applicants in interior and exterior general consular waiting areas.

B. Audio Systems:

1. Audio Digital signal processor (DSP): Provides echo cancellation and audio processing for full duplex teller window communications, as well as in consular office and public area paging system. DSP shall include masking sound generator and filter set to allow producing and adjusting masking sound on Applicant side of Teller window as specified in this Section.
2. Audio speaker for teller side: Provide in-wall speaker or recessed-ceiling-mounted speaker as indicated on Drawings.
3. Audio speaker for applicant side: Provide in-wall speakers within each side wall or recessed ceiling-mounted speaker, as indicated on Drawings.
4. Teller Microphone: Provide 457 mm (18”) gooseneck tabletop microphone. Provide base with mute button for microphone and headset plug-in jack; coordinate with control panel.
5. Applicant boundary zone microphone: Provide wall mounted on public side with mounting to single gang wall plate. Place microphone to provide direct coverage of teller window glass surface to ensure adequate discrimination between applicant voice and waiting area noise.
6. Provide amplification for audio speakers at each teller window.
7. Waiting Area Loudspeakers: Place loudspeakers to serve paging zones in consular waiting area and in associated outdoor waiting area. Speaker indoor coverage shall conform to ANSI/AVIXA: A102.1:2022 "Measurement and Classification of Audio Coverage Uniformity in Listener Areas."
8. Produce volume-controlled masking sound through speakers on Applicant side.
9. Connections and Configurations:

    a. Provide connections and configuration to facilitate connection of headset by teller at A/V control panel. These connections shall be wired in standard fashion to facilitate use of commercial off-the-shelf (COTS) 4 or 5 pin XLR headphones with microphone boom.
    b. To facilitate paging announcements from queuing system processor, provide audio interface with consular queuing system; see Section 275405 “Consular Queue Management System Infrastructure and Displays.”

C. Remote Control Systems:

1. Provide integrated control system for control teller and public areas.

    a. Provide controls on teller-side countertop at each teller window location.
    b. A/V Control Panel: Provide paging and muting control, with limited volume, for teller via A/V control panel. Control functions shall include the following:

1) Display number of window being controlled.
2) Provide "Officer Microphone" volume control. This controls volume and muting of teller's speech being heard by applicant. Provide indicator that displays relative position of volume. Limit range to prevent excessive loudness and feedback.
3) Provide "Applicant Microphone" volume control. This controls volume and muting of teller's speech being heard by applicant. Provide indicator that displays relative position of volume. Limit range to prevent excessive loudness and feedback.
4) Provide "Mute" button on teller microphones. When this button is pushed, only the officer microphone is muted. When button is pushed again, microphone shall become operational again. Include visible indicator on teller microphone of mute status.
5) Provide "Mute" button on applicant microphones. When this button is pushed, only the applicant microphone is muted. When button is pushed again, microphone shall become operational again. Include visible indicator on teller microphone of mute status.
6) Provide "Mute All" button on A/V control panel and/or on microphone base unit. When this button is pushed, officer and applicant microphones shall be muted.
7) Provide "Paging Waiting Room" button. When this button is pushed, officer's microphone shall be routed the speakers in the waiting area for public announcements. The button should indicate that paging at this window is active. Control system should only allow for paging from one window at a time.
8) Number of programmed paging zones shall be as determined by Project Director/COR as indicated or based upon input from OBO/PDCS/DE/EE/CBT, and labeling nomenclature shall be provided for zones.

D. Network:

1. Device control and digital audio networks (see the Part 2 Article on DIGITAL AUDIO NETWORK COMPONENTS) shall be distributed separately from building network.
2. Use of intra-building optical fiber is indicated on Drawings, or if not, shall be coordinated with Project Director/COR based upon input from OBO/PDCS/DE/EE/CBT.
3. Digital audio networks shall link each audio processor frames to facilitate paging functions and interconnectivity.
4. Provide network switched to support digital audio network device connections.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. General:

1. Provide equipment, components, software, accessories, and miscellaneous items necessary to achieve fully functioning audio systems for consular teller intercoms and consular paging.
2. System design shall conform to ANSI/AVIXA: D104.01:2023 "Documentation Requirements for Audiovisual Systems."

B. Audio Performance Characteristics:

1. Frequency Response: 30 Hz – 18 KHz, within 3.0 db
2. Signal to Noise Ratio: 55 dB minimum
3. Total Harmonic Distortion: 1 percent maximum from 30 Hz-15 Hz (THD)

C. Audio Intelligibility:

1. Consular intercom and paging systems shall achieve minimum performance for Speech Transmission Index (STI) exceeding the level of "Fair" quality (i.e., the STI level meets or exceeds 0.60 STI) identified in International Standard IEC 60286-16 (2003-05), "Objective Rating of Speech Intelligibility by Speech Transmission Index."
2. White noise or spoken word source within Consular Waiting Room shall be set to 65 dBA at 1M to simulate conversation level within Consular Waiting Room.
3. Noise source shall be positioned to emulate waiting applicants.

D. Paging Zone Amplifier Load: Provide 70V amplification for paging zones. Total of loudspeaker load presented to amplifier shall not exceed 80 percent of amplifier's wattage capacity.

E. Audio Video Bridging (AVB):

1. Transport: Conform to IEEE 802.1.

F. Dante audio

1. UDP PTPv1

G. [Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.]

1.5 SUBMITTALS

A. Product Data: Manufacturer's product information and data sheets for all equipment items. Products and options selected in data sheets shall be clearly identified. Data sheets without identification of selections may be rejected.

B. Coordinate timing and content of submittals with those for Section 275405 "Consular Queue Management System Infrastructure and Displays" for output of paging and input for queueing system.

C. Shop Drawings: Signed and sealed by a qualified professional engineer. Complete system shop drawings depicting the following information:

1. All point-to-point wiring single-line diagrams, equipment interconnections, component values and showing complete letter and number identification of all wire and cable as well as jacks, terminals and connectors.
2. All panels, plates, and designation strips, including details relating to terminology, engraving, finish, and color.
3. Complete set of remote touch panel layouts, and brief functional description of programming depicting each button and it's description and function
4. All equipment modifications.
5. Cabling run sheets and field wiring details.
6. Wire specifications and assignment by use.
7. Elevation drawings of each equipment rack.
8. Complete and detailed schematic drawing including all items of equipment, and mounting heights.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of items involved:

1. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. [Manufacturer Seismic Qualification Certification: Submit certification that central control cabinets, accessories, and components will withstand seismic forces applicable to the Project. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.]

F. Qualification Data for Consular AV Installer:

1. Identify three similar projects of the same or greater magnitude and scope within last five years. Include statement that Consular A/V Installer was actively involved in those projects. Provide current contact names and telephone numbers, as well as job description.
2. Identify project team for Consular A/V Installer, including resumes demonstrating history with similar projects of similar or greater magnitude and scope.

3. Certificates: Factory-training certificates for Installers that correspond to work for this project.
4. Factory-trained and certified engineer for DSP Software and control product for product lines included in this project, including for training and service. Submit certificates and credentials.

G. Field quality-control test reports.

H. Closeout Submittals: At completion of installation, provide the following information:

1. Equipment inventory listing manufacturer, model number and serial number for all equipment items furnished.
2. Record drawings for each system installation, showing all equipment items, interconnection of equipment and all cable label designations.
3. Teller-Side User Guide: In addition to laminated guides identified in Article on IDENTIFICATION AND INSTRUCTIONS, provide editable version to facilitate updates to guides.
4. Functional Block Drawing: Identify all input and output circuit cable and terminal block numbers as well as all jack field circuit I.D. designations. Drawing shall be in readable logical format that is understandable to both technical and non-technical staff.

   a. Provide separate copy of this drawing; place under clear acrylic sheet, and mount on inner surface of A/V equipment rack door.

5. Un-complied DSP, Control processor and control touch panel code files
6. Hardware log in information (Admin passwords)

I. Operation and Maintenance Data: For intercommunication system to include in emergency, operation, and maintenance manuals. Provide hardcopy manual and electronic version.

1. The Operation section shall describe all typical procedures necessary to activate each system to provide for functional requirements as listed in this section.
2. The Maintenance section shall provide recommended maintenance schedule with reference to applicable pages in manufacturer's maintenance manuals. Where manufacturer provides inadequate information, Consular A/V Installer shall provide information necessary for proper maintenance.
3. Submit replacement parts lists in support of all items of equipment, either stock manufactured item or custom built.
4. Submit data on same electronic storage as with programming code and software for system.

1.6 OWNERSHIP OF PROPRIETARY MATERIAL

A. Government retains all rights to software and passwords used for this project.

B. Government will sign copy of manufacturer's standard software and firmware licensing agreement as condition of this contract. Such license shall grant use of all programs and application software to Government as defined by manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. Licensing agreement shall not preclude use of software by individuals under contract to Government for commissioning, servicing, or altering system in future. Use of software by individuals under contract to Government will be restricted to use on Government's computers, and only for purpose of commissioning, servicing, or altering installed system.

D. All project developed software, files and documentation shall become property of Government.

1.7 QUALITY ASSURANCE

A. Delegated Design Responsibility: Contractor shall retain Manufacturer's authorized representative. Representative shall possess the following qualifications:

1. Be trained and approved for design and installation of systems required for this Project.
2. Be Certified Technology Specialists (CTS-D).
3. Have minimum 10 years industry experience with design of similar systems with complex performance requirements.
4. Be acceptable to the Project Director/COR to perform responsibilities of Delegated Design for this Work.

B. Consular AV Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project and are Certified Technology Specialists (CTS and CTS-D), with minimum 10 years industry experience.

C. Qualification for Engineers for DSP Software and Control Products: Manufacturer-certified and factory-trained for product line training, software programming, and service.

D. Independent Testing Agency Qualifications: Testing agency that is member company of InterNational Electrical Testing Association (NETA), and that is acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE.

1. Testing Agency's Field Supervisor: Person currently certified by NETA or National Institute for Certification in Engineering Technologies (NICET) to supervise on-site testing specified in this Section.

E. Comply with the OBO Electrical Code; see Section 270508 "Common Work Results for Telecommunications."

F. Comply with National Fire Alarm and Signaling Code (NFPA 72).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces with environments controlled within manufacturers' ambient temperature and humidity tolerances for non-operating equipment.

1.9 COORDINATION

A. Coordinate layout and installation of ceiling-mounted speakers (if used) with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.10 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date for a period of one calendar year provide system maintenance service based on manufacturer's recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. In addition to the initial year of maintenance service, provide a proposal for a renewable option year. The option year proposal shall be submitted 60 days prior to the end of the initial maintenance contract period.

B. Maintenance service shall be performed by Consular A/V Installer, and shall inclusive of:

1. Telephone Assistance: Consular A/V Installer shall respond via telephone within one business day of notification. This first contact will be to outline nature of problem or functional anomaly. Consular A/V Installer shall make available an individual knowledgeable with installed system that can address specific system issues described by system operators.
2. On-Site Repair Assistance: Consular A/V Installer shall be available to provide capable technicians for on-site service of systems equipment or control software. Technicians dispatched shall be familiar with installed system with complete knowledge of products used in systems configuration. Technicians dispatched shall have complete ability to address nature of system anomaly or performance difficulty described. Provide on-site response within one week. Service shall be available during normal business hours of the facility, Monday through Friday, 8:00 am until 5:30 pm.
3. Consular A/V Installer shall provide two scheduled service visits to inspect, maintain, and adjust systems during each year of service. First visit shall occur approximately six months after installation, and subsequent visits shall occur near end of each six month period of the service.

    a. Adjustment: During first scheduled service visit provide on-site assistance in adjusting system to suit actual occupied conditions. Refer to Part 3 requirements for START-UP SERVICE in relation to initial adjustment prior to operation.

PART 2 - PRODUCTS

2.1 GENERAL

A. System manufacturer shall furnish all equipment. In addition, manufacturer shall furnish all accessory components to this system that are not identified in the Summary Article in RELATED SECTIONS.

2.2 AUDIO EQUIPMENT

A. Audio dynamic sound processor (DSP):

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to the following:

a. Biamp

B. Consular Side Speakers:

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to the following:

a. Tannoy
b. JBL
c. Electro-Voice
d. Biamp
e. QSC

2. Speakers may be either recessed ceiling or surface mounted depending on ceiling architecture at the interview window.

C. Applicant Side Speakers:

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products may be incorporated into the Work include but are not limited to the following:

a. Tannoy.
b. JBL,
c. Electro-Voice,
d. QSC
e. Biamp
f. Radio Design Labs (RDL)

D. Audio Amplifier: Provide amplification for speakers at each teller window.

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products may be incorporated into the Work include, but are not limited to, the following:

a. Biamp
b. QSC

E. Teller Gooseneck Microphone:

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products may be incorporated into the Work include but are not limited to the following:

a. Audiotechnica
b. Clock Audio
c. Shure

F. Applicant Microphone:

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to the following:

a. Crown
b. Audix
c. Clock Audio (CU-C012-RF-CP series)

G. Audio Connections:

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products that be incorporated into the Work include but are not limited to the following:

a. Brahler
b. DIS

H. Waiting Area Speakers:

1. 70 V speaker distribution with volume control over entire coverage area on each speaker.

I. Teller headset:

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products may be incorporated into the Work include but are not limited to the following:

a. Shure
b. Audio-Technica

2.3 REMOTE CONTROL SYSTEMS

A. A/V Function Control System:

1. Acceptable Manufacturers: Subject to compliance with functional description of system and other requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Creston
b. Biamp

2.4 DIGITAL AUDIO NETWORK COMPONENTS

A. Provide network connections: AVB, Dante, or approved equal.

B. Provide network switches to support digital audio network device connections.

2.5 MISCELLANEOUS EQUIPMENT

A. Consular Audio Equipment Rack: Provide racks for rack-mounted consular audio equipment. Included rack-mounted shelves for equipment which is not rack-mounted. Provide associated wire management.

B. AC Power Conditioning for Equipment Rack:

1. Provide power devices based upon host country power standards.

C. AC Power Uninterruptible Power Supply (UPS): Provide for all audio signal processor and control system equipment. Size to operate paging and intercom for minimum of 10 minutes.

D. Cables: The following represents Basis of Design unless indicated otherwise on Drawings:

1. Type 1: West Penn D25921 Audio (Mic/Line shielded plenum).
2. Type 2: West Penn D25924 Audio (for 16- and 8-ohm speakers shielded plenum).
3. Type 3: West Penn D25923 Audio (70-V speakers shielded plenum).
4. Type 4: West Penn D254246 Category 6.
5. Type 5: West Penn D25291 RS-232 Distribution.
6. Type 7: West Penn 254245 Category 6.

E. Connection Plate Receptacles: Unless otherwise detailed, provide the following types of panel receptacles on connection boxes, panels, plates, and wire ways:

1. Audio (microphone or line level): XLR or RJ45 type.
2. Audio (headset): XLR type
3. Network: RJ45 (8P8C) type.

2.6 SOFTWARE

A. Provide all programming and configuration necessary to provide a complete and working system conforming to functional and performance requirements identified in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Installation includes setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and other work whether or not expressly required herein which is necessary to result in complete operational systems.
2. Installation shall be performed by installers authorized by Manufacturers.
3. Installation shall provide system which conforms to functional and performance requirements of this Section.

B. Physical Installation:

1. Firmly secure equipment in place unless requirements of portability dictate otherwise.
2. Secure with fasteners adequate to support load from system with safety factor of at least three times total load.
3. Secure boxes, equipment, and similar components plumb and square.
4. Install equipment and cable in manner that facilitates operational efficiency and overall aesthetic factors.

C. Teller/Applicant Speakers: Refer to Drawings for mounting type.

1. Ceiling-Mounted Speakers: Speakers shall be ceiling-recessed. Center ceiling-mounted speakers over teller and applicant, as applicable.
2. Wall-Mounted Speakers: Place at or above height of teller window assembly, as indicated on Drawings. Provide adjustable mount to facilitate satisfying audio performance requirements. Refer to Drawings as to whether speakers are recessed or surface mounted.

D. Cable Installation:

1. Mark cables, regardless of length, with wrap-around number or letter cable markers at both ends. There shall be no unmarked cables at any place in the system. Marking codes used on cables shall correspond to codes shown on drawings or wire run sheets.

2. Neatly strap, dress, and adequately support inter-rack cabling.
3. Group cables according to signals being carried. To reduce signal contamination, form separate groups for the following cables:

    a. Power cables.
    b. Control, data cables, and Cat 6 UTP.
    c. Audio cables carrying signals less than -20 dBm.
    d. Audio cables carrying signals between -20 dBm and +20 dBm.
    e. Audio cables carrying signals above +20 dBm.

4. Do not allow audio cables to run in same raceway as video, computer video or power cables.
5. As general practice, run power cables, control cables, and high level cables on left side of equipment rack as viewed from rear. Run other cables on right side of equipment rack, as viewed from rear.
6. Cut cables to length dictated by run. Splices in pull boxes are not permitted without prior permission of Project Director/COR. For equipment mounted in drawers or on slides, provide interconnecting cables with service loop of appropriate length.
7. Do not install cable with bend radius less than that recommended by cable manufacturer.
8. Install cable in 50 mm below-grade conduit from Consular equipment room to locations of paging devices in outdoor Consular waiting area. See Division 26 section on raceways and boxes for installation of conduit outside of building.

3.2 GROUNDING

A. Procedures: To minimize problems resulting from improper grounding and to achieve maximum signal-to-noise ratios, adhere to the following:

1. General: Because of great number of possible variations in grounding systems, it is the responsibility of Contractor to follow practices below, and to deviate from these practices only when necessary to minimize cross talk and to maximize signal-to-noise ratios in the audio, video, and control systems. See Section 270526 “Grounding and Bonding for Communications Systems” for general requirements.
2. Install secondary system grounding conductors from all racks, audio consoles, and ungrounded audio equipment in each area to primary system grounding point for area
3. Do not use AC neutral conductor, either in power panel or in receptacle outlet, be used for system ground; no exceptions are permitted.
4. Audio Cable Shields: Ground audio cable shields at one point only; no exceptions are permitted. For inter and intra-rack wiring, shield be connected at one end only. For ungrounded portable equipment, such as microphones, connect shield at both ends but grounded at only one end.
5. Speaker Cable Shields: Ground all speaker cable shields at rack enclosure and bond to technical ground.

3.3 SYSTEM PROGRAMMING

A. Programming: Fully brief COR and OBO/PDCS/DE/EE/CBT on available programming options. Record COR's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

1. Create a functional and intuitive GUI (Graphic User Interface) tailored to the specific needs and requirements of the project.
2. Incorporate key features as defined in the project specifications.
3. Provide a beta version of the GUI for review by the PD/COR with input from OBO/PDCS/DE/EE/CBT.
4. Make all necessary GUI revision based on feedback received by Post and OBO/PDCS/DE EE/CBT.
5. Submit the revised GUI for the final approval to Post and OBO/PDCS/DE/EE/CBT.
6. Ensure all issues or concerns raised during the review are addressed prior to the deployment.

3.4 IDENTIFICATION AND INSTRUCTIONS

A. Associated A/V Equipment Room: Provide wall-mounted, full-size system diagrams to facilitate system setup and troubleshooting. Mount diagrams under clear plastic for protection.

B. Teller-Side Window Station: Provide simplified user guide for tellers. Laminate each guide for durability.

3.5 FIELD QUALITY CONTROL

A. Contractor System Checkout: Before Acceptance Tests are scheduled, Consular A/V Installer shall perform their own system checkout as quality control procedure. They shall furnish all required test equipment and perform all steps necessary to determine performance of system to conform to requirements of this Section. This work shall include the following:

1. Checkout procedures shall be consistent with test standards identified under requirements for “System Acceptance Tests” below.
2. Test all audio and related systems for comply with System Performance Requirements.
3. Check all control functions, from controlling devices to controlled devices, for proper operation.
4. Perform preliminary adjusting, balancing, and alignment of system equipment for optimum quality and for conformance with manufacturer’s published specifications. Establish and mark normal settings for all level controls and record these settings in “Operation and Maintenance Data” submittal.
5. Maintain documentation on-site of all performance tests for reference by Project Director/COR and representative of independent testing agency during System Acceptance Tests.

B. Systems Acceptance Tests:

1. Contractor shall engage independent testing agency to perform tests identified below. System Acceptance Tests shall not be performed until Contractor's System Checkout has been completed. Project Director/COR or their representative may monitor System Acceptance Tests. These tests shall consist of the following:

    a. Testing Standards: International Standard IEC 60268-16, as identified in Article on SYSTEM PERFORMANCE REQUIREMENTS.
    b. Testing Equipment: Contractor is responsible for supplying test equipment required to perform tests.
    c. Two complete hardcopy sets of record drawings, run sheets, manuals, and other required pre-testing construction submittals shall be on on-site, delivered to Project Director/COR prior to scheduling of Acceptance Tests.
    d. Prior to commencing testing, Contractor shall perform physical inventory of installed equipment and components on site to confirm sufficient presence of items necessary to obtain acceptable test results.
    e. Consular A/V Installer shall demonstrate operation of all system equipment.
    f. Subjective and objective tests shall be performed to determine compliance with requirements of this Section. Confirm that sampling of 25 percent of teller windows and paging zones achieve required minimum STI.
    g. If further adjustment is required to conform to project requirements, or if equipment is defective and requires repair or replacement, tests may be suspended or continued at discretion of Project Director/COR. Acceptance testing shall then be continued once Consular A/V Installer has identified readiness of system. Costs associated with suspension of testing, including additional costs for testing representatives of Project Director/COR, are responsibility of Contractor.

2. Performance of test audio signal paths for Performance Standards Tests shall include, as an example but not limited to, the following:

    a. Audio:

        1) Communication of each teller window station. Test of levels shall include echo cancellation check.
        2) Paging capabilities from each teller window station.
        3) Monitoring station capabilities.
        4) Testing shall be from all source inputs (e.g., microphones, audio tape units) through all (e.g., mixers, ADA's, switchers) to all signal destinations.
        5) Test all switches, sound levels, and overall intelligibility.
        6) Test and adjust, as necessary, masking sound spectrum and levels at Teller window Applicant side at position of Applicant 1.5M (5 feet) above finished floor. Submit report of final spectrum and overall levels at each window and compare with levels required in the Part 1 Article on SYSTEM PERFORMANCE REQUIREMENTS.

7) Delineation of above signal paths does not exempt Contractor from responsibility of checking all paths and outlets for appropriate compliance with the Part 1 Article on SYSTEM PERFORMANCE REQUIREMENTS during prior Contractor System Checkout.
8) During Acceptance Testing, all equipment shall be operated under standard conditions recommended by manufacturer.

b. Control:

1) Audio volume, include inbound and outbound levels.
2) Mute inbound and mute outbound operations.
3) Paging selections.
4) Masking sound adjustment.

c. Miscellaneous:

1) Cable identification markings.
2) Cable routing integrity and neatness.
3) Location of speakers, microphones, and controls.

3.6 CLEANING

A. Upon completion of installation, clean equipment in accordance with manufacturer’s instructions.

3.7 STARTUP SERVICE

A. Engage factory-authorized service representative to perform startup service and initial system programming.

B. Adjust sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.8 PROTECTION

A. During installation, and up to date of occupancy, protect finished and unfinished work against damage and loss. In event of such damage or loss, replace or repair such work at no cost to Government.

3.9 DEMONSTRATION

A. Comply with Division 01 Section 017905 "Demonstration and Training" for general requirement of demonstration and training documents.

B. A manufacturer's representative or system-certified instructor shall provide "hands-on" training sessions to individuals identified by Project Director/COR. All training shall take place after audio systems are operational, and after Government-Furnished Government-Installed (GFGI) components and software for Consular Queue Management System is operational; see Section 275405 "Consular Queue Management System Infrastructure and Displays."

1. System User Training:

a. Training Sessions:

1) On-site classroom instruction of 1-hour duration per session, with each session training tellers serving 10 windows. The number of class sessions shall be one for each 10 teller windows.
2) On-site field demonstration sessions of the same individuals that participated in classroom sessions, but on window-by-window basis. Sessions shall be ½-hour duration for each window, with two individuals being trained in each session.

b. Training Content:

1) Operation of teller window control panel, volume level, and paging area selection(s).
2) Microphone use and techniques for best intelligibility.

2. Technical Support Personnel Training; 8-hour session; classroom 2 hours and Field Demonstration 6 hours. The session shall include the following topics:

a. Operation of teller window control panel (conceptual design, configuration and normal use parameters).
b. Microphone use and techniques for best signal to noise ratio.
c. General Care and system maintenance.

END OF SECTION 275105

SECTION 275118 – SOUND MASKING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer/DSP controlled sound masking generators.
2. Amplifiers.
3. Wiring.
4. Masking speaker assemblies.
5. Control and control software.

B. Related Sections include the following:

1. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
2. Section 270508 “Common Work Results for Telecommunications.”
3. Section 270526 “Grounding and Bonding for Communications Systems.”
4. Section 270533 “Identification for Communications System.”
5. Section 271116 “Communications Cabinets and Frames.”
6. Section 271505 “Communications Horizontal Cabling.”
7. Section 275105 “Audio Systems for Consular Services.”

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508.
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508.

1.3 DEFINITIONS

A. Covered Spaces: Spaces above which masking speakers are installed; refer to project Sound Masking system speaker layout drawings.

1.4 SYSTEM DESCRIPTION

A. Permitted Locations: Sound masking system shall be included within General Work Areas (GWA) but is not permitted within private offices or Controlled Access Areas (CAA). Sound masking is required in the Consular Work Area.

B. DSP-controlled sound masking system with individually controllable zones of speakers located above or within the ceiling as shown and indicated on drawings.

C. Support and bracing of loudspeakers suspended from structure above in conformance with OBO Building Code, including provisions for seismic restraint in locations where applicable.

D. Signal Levels: Individually adjustable for each of 14 one-third octave bands centered at 100 through 5000 Hz for sound-masking noise channels.

E. Sound-Pressure Level Produced by System: Match contour in Table 3.4, "Sound Pressure Level Contour," with smooth roll-off below 125 Hz and above 2500 Hz.

1. General overall level shall be as follows:

a. 45 dBA in open plan areas and Consular Teller Windows (Officer Side).
b. 47 dBA in interior Consular Waiting areas.
c. See Section 275105 "Audio Systems for Consular Services" for Consular Teller Windows (Applicant Side).

2. Measurements: Test under calibration conditions as identified in Article on FIELD QUALITY CONTROL.

F. Maximum Local Variance of Sound-Power Level: Overall 3 dBA throughout each open plan areas (away from diffusers or grilles).

G. Sound Quality: No audible hum or noise from this system when sound masking generator is turned off.

1.5 SUBMITTALS

A. Product Data: For each type of product installed. Include U.S. recognized testing laboratory listing data.

B. Shop Drawing: Dimensioned plans and elevations showing minimum clearances and installed features and devices for system components. Show types and locations of masking speakers and their wiring connections, channel and/or primary and secondary hub assignments, and axis orientations. Show ducts, beams, and other significant sound-reflecting and –absorbing elements in ceiling space and show locations of partitions below ceiling. Include a diagram showing

interconnection of major system components for each zone and channel and indicating grounding connections.

1. Wiring Diagrams: For power, signal, and control wiring including all devices.

C. Operation and Maintenance Data: For sound-masking equipment and components, including emergency, operation, and maintenance procedures.

D. Qualification data for firms and persons as required in Article on QUALITY ASSURANCE.

1. Installer.
2. Testing Agency.

E. Field Quality Control Reports: Include field quality control reports and test results for initial tests and inspections and for final acceptance testing.

F. Warranties: Submit two copies conforming to warranty requirements of this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer trained and approved by manufacturer of sound-masking equipment. This installer shall produce shop drawings.

B. Testing Qualifications:

1. An independent agency with the experience and capability to conduct testing of sound-masking systems according to ASTM E 1130. Required experience includes having tested a minimum of five different projects involving sound masking systems within the last five years, each system similar in complexity to Project system.
2. A factory authorized representative.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by qualified testing agency acceptable to Project Director based upon input from OBO/PDCS/DE/EE and marked for intended location and application.

D. Comply with the OBO Electrical Code; see Section 270508 “Common Work Results for Telecommunications.”

E. Comply with UL 813 “Standard for Commercial Audio Equipment” except where more stringent standards are identified in this Section.

1.7 COORDINATION

A. Coordinate quantity and arrangement of speaker assemblies with ceiling space configuration and with components occupying ceiling space such as structural members, pipes, air-distribution components, raceways, cable trays, and recessed lighting fixtures.

1.8 WARRANTY

A. Extended System Warranty: Manufacturer's standard form signed by the manufacturer in which manufacturer agrees to repair or replace system components that fail in materials or workmanship within specified warranty period.

1. Initial One-Year Warranty Period: Manufacturer shall repair or replace system components that fail and must restore operation of system.
2. Extended Warranty Period: Manufacturer shall respond to phone inquiries regarding failure within three days to provide guidance for restoring systems. Where components have failed, manufacturer shall provide replacement component to site within two weeks of inquiry. General adjustments and retuning of the system are not covered during extended warranty period.
3. Failure includes, but is not limited to, inability to generate sound masking, and relates to failure in materials or workmanship.
4. Warranty Period: Five (5) years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish the following extra materials that match products installed. Package extra material with protective covering for storage and identified with labels describing contents.

1. Sound-Masking Speaker Assembly Components:

a. Ten speakers.
b. Two primary hubs.
c. Three secondary hubs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Logison.

2. Lencore Acoustics Corp.
3. Biamp (Cambridge Sound Management).

B. Basis-of-Design Product: The Basis-of-Design is the following system:

1. Biamp.

2.2 CONTROLS

A. Software Control Devices: System shall be controlled by manufacturer-specific software and/or controllers, with individually controlled zoned and/or individual speakers.

B. Control Software:

1. Software shall facilitate control of all adjustments for system, and of individual speakers and zones throughout entire system, from a computer and/or wall controller. Control capabilities shall include:

a. System setup.
b. Sound masking volume and equalization.
c. Report all system settings.
d. Perform network diagnostics for system.
e. Wall mounted controllers located within sound masking space for individual zone controls.

2.3 PRIMARY NETWORK HUB

A. Each Primary Network Hub shall include:

1. DSP-based masking sound generator.
2. An individual 1/3 of an octave, 23-band equalizer for masking.
3. Individual volume control for masking.
4. Network communication components.
5. Audio amplifier.
6. Approximate Dimensions: Diameter 125 mm (5 inches); Height less than 50 mm (2 inches).

2.4 SECONDARY NETWORK HUB

A. Each Secondary Network Hub shall include:

1. Loudspeaker connection.
2. Signal connections to other primary/secondary devices.

3. Approximate Dimensions: Diameter 125 mm (5 inches); Height less than 50 mm (2 inches).

2.5 LOUDSPEAKER ASSEMBLY

A. Each Loudspeaker Assembly shall provide:

1. Biamp speaker shall be Qt Active Emitter; they shall be type that is mounted in ceilings down-firing to occupied space.
2. Other manufacturer speakers shall be cone speaker 100-200 mm (4-8 inches) diameter within insulated housing; assembly shall comply with local codes and regulations.
3. Frequency Response: 100-8000 H +/-6dB.
4. Assembly: Specific to sound masking manufacturer.
5. Connectors: Connection to network devices.
6. A suspension chain as needed for suspension position and tool-less length adjustment clip
7. Acoustically damped enclosure.
8. Tool-less, on-site adjustment of upward/downward loudspeaker orientation in accordance with manufacturer's system design.

2.6 CABLE ASSEMBLIES

A. Assembly: Cable assemblies shall provide power, audio and control signals over a signal cable assembly.

B. Connectors: Over-molded micro-connectors.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Speaker Assemblies: Suspended from structure above.

B. [Install seismic restraints on speakers. Comply with OBO Building Code requirements for seismic-restraint devices associated with the project location.]

C. [Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and unless otherwise indicated.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.
3. Conceal raceways and wiring except in unfinished spaces.]

D. [Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Section 271505 "Communications Horizontal Cabling," including requirements for cable trays.
3. Comply with requirements for raceways and boxes specified in Division 26 Section on raceways and boxes for electrical systems.]

E. Wiring within Assembly Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

F. Exposed Cable: Install parallel to building lines, follow surface contours, and support as recommended by manufacturer.

G. Grounding: As recommended by manufacturer unless more stringent requirements are indicated. Ground equipment and conductors to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments with a maximum of 5-ohm to ground at main equipment location. Measure, record, and report ground resistance.

H. Impedance Matching: For system components, including connecting cable, provide end-to-end level and impedance-matched signal paths. Use matching networks and balancing devices at connection where necessary to avoid mismatches.

I. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 SYSTEM CONFIGURATION

A. Software Control Devices: Control Devices shall be as necessary to control individual speakers or zones of speakers.

B. Wall mounted control devices shall be necessary to control individual speakers or zones of speakers.

C. Power Supply:

1. Power network devices and control panels from controller served by a dedicated 20 amp quad outlet.
2. Locate power supplies within 200 feet maximum from speakers, or Power-Over-Ethernet (POE) switches nominal 76M (250 ft) from ceiling-plenum mounted remote-control units.

3.3 IDENTIFICATION

A. Use color-coded conductors and apply sire and cable marking tape to designate wires and cables so media are identified in coordination with system wiring diagrams. Comply with requirements for identification in Section 270533 "Identification for Communications Systems." Use white as coding for sound masking system CAT6 cabling.

B. Label speaker assemblies as to channel, zone, and address.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: During project warranty period, engage a factory-authorized service representative to perform initial inspections and tests identified in the following paragraph, and to adjust components, assemblies, and equipment installations, including connections.

B. Initial Tests and Inspections:

1. Operational Test: Start system to confirm proper operation. Remove malfunctioning units, replace with new units, and retest. Make initial sound-spectrum and –level adjustments for each zone.
2. Test and adjust controls and safeties.
3. Inspection of Proper Identification: Verify that installed units and controls, and installed interconnecting wires and terminals are identified in accordance with Article on IDENTIFICATION.
4. Pretesting: Tune, align, and adjust system and pretest components, wiring, and functions to verify that they comply with specified material, installation, and performance requirements.
5. Masking Sound-Pressure-Level Adjustments: Adjust systems to achieve specified sound levels.
6. Correction and Retest: Replace damaged and malfunctioning controls and equipment. Correct deficiencies and retest until satisfactory performance and conditions are achieved.

C. Final Acceptance Testing: Provide minimum of 30 days' notice to Project Director/COR and OBO/PDCS/DE/EE of acceptance test performance schedule. Schedule tests after pretesting has been successfully completed. This testing shall be performed by the independent testing agency or a factory authorized representative.

1. Tests and Calibration Conditions: Spaces shall be completely furnished but unoccupied; lights and HVAC systems shall be turned on; HVAC system testing and balancing shall be completed; and other sources of background noise such as electronic ballasts, lighting relay panels, and low voltage transformers shall be in installed.
2. Test Conditions: Complying with ASTM E 1130 and calculated according to ANSI S3.5.
3. Instrumentation: Use a professional-quality, sound-level meter with octave-band filters; reference documentation of recent calibration against recognized standards.

4. Record test observations, readings, and corrective actions.
5. System Tests: Include the following for each system zone:

   a. Ambient Sound-Level Tests: With system off, measure ambient sound level in one-third octave bands. Also measure ambient sound level as a single, wide-band, A-weighted reading.
   b. Frequency Response Adjustment and Test: Adjust one-third octave frequency bands and other unit filters to provide response. Adjust to meet requirement of sound spectrum in space. Comply with ANSI S3.2, ASTM E 1110, and Consumer Electronics Association CEA 426 "Loudspeakers, Optimum Amplifier Power."

6. Walk-through Test: People in covered spaces cannot discern speaker locations.

D. Retest: Correct deficiencies identified by tests and observations, and retest until conforming to requirements.

E. Recording Control Settings and System Adjustments: Save final control settings and programming to electronic file for archive by manufacturer's representative and the Government.

F. Acoustical Performance Requirements:

1. Sound-Masking Frequency Spectrum: Spectrum shall conform to shape described in Table 3.4, "Sound Pressure Level Contour" below:

TABLE 3.4

SOUND PRESSURE LEVEL CONTOUR

1/3 Octave Band Center Frequency (Hz - Cycles per Second)	**Sound Pressure Level** (dB re:20microPa)
100	47
125	46
160	45
200	44
250	43
315	41
400	40
500	39
630	37

TABLE 3.4

SOUND PRESSURE LEVEL CONTOUR

1/3 Octave Band Center Frequency (Hz - Cycles per Second)	**Sound Pressure Level** (dB re:20microPa)
800	35
1000	34
1250	31
1600	29
2000	27
2500	25
3150	22
4000	19
5000	16
100-5000 Hz dBA Level	45 dBA

2. Uniformity of Background Sound Coverage: Measure sound pressure level in each octave band from 125 Hertz to 4000 Hertz at each test location. Test locations shall be at least 1200 mm (4 feet) from any large sound reflecting objects (e.g., file cabinets and desks). Overall sound level variances shall be no greater than +/-3 dBA. To improve evenness of coverage, system installer shall perform adjustments such as adjusting loudspeaker transformer taps or gain controls and adding or relocating speakers.
3. If tests show that equipment is in any way defective or at variance with this Section, the system shall be adjusted at no cost to the Government, including expenses associated with subsequent testing required to demonstrate compliance with this Section and Construction Drawings.

G. Measured data of distribution of octave band random noise (center frequencies from 125 Hertz to 4000 Hertz) produced by loudspeakers shall be obtained for various positions within occupied spaces. This data shall be recorded on NC graph sheets.

3.5 DEMONSTRATION

A. Comply with Division 01, Section 017905 "Demonstration and Training" for general requirements of demonstration and training documentation.

B. Engage factory-authorized service representative to train Government O&M personnel to adjust, operate, and maintain the system.

END OF SECTION 275118

SECTION 275124 GENERAL-USE TELLER WINDOW INTERCOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies intercommunication systems at teller windows other than those at Consular Waiting Area:

B. Related Sections:

1. Section 085652 "Aluminum Security Teller Windows" for coordination with those window units.
2. Other Divisions 26 and 27 sections for conduits, wire ways, connection boxes, pull boxes, junction boxes, and outlet boxes permanently installed in walls, floors, and ceilings, and for interface with panelboards to power each intercom.
3. Section 275105 “Audio Systems for Consular Services” for intercommunication systems serving consular teller windows, and for paging at general interior and exterior consular waiting areas.
4. Section 283325 “TSS Intercommunications Systems” for post security personnel communication with other security personnel, and post security personnel interface for remote access control.

1.2 SYSTEM DESCRIPTION

A. System Elements:

1. Master Station: Element used by personnel providing service or information. Located on “protected side” of FE/BR teller window.
2. Substation: Element used by individuals seeking service or information. Located on “attack side” of FE/BR teller window.

B. System Locations: Provide at the following locations as applicable:

1. Office Main Lobby: MSG interface at chancery or office annex at MSG booth (e.g., Post 1).
2. FM Cashier: FM cashier service with post staff and families within office General Work Area (GWA). Refer to Section 275105 “Audio Systems for Consular Services” for Cashier Booth within Consular Waiting Area.
3. CAC Guard Booths: For MSG interface with individuals seeking information/service at teller windows on the compound perimeter, within the CAC screening area, and with the CAC sallyport (where applicable).
4. Consular CAC Visa Passback: For Consular Affair staff interface with visa applications at compound perimeter.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data.

B. Shop Drawings:

1. Coordinated details for interface with FE/BR teller windows.

C. System Test Performance Confirmation: Provide notification that each system location has been tested in accordance with the Article on FIELD QUALITY CONTROL, and that each system location conforms to the requirements for function and performance identified in this Section.

D. Operations and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Manufacturer and Supplier Qualifications:

1. The term "manufacturer" is defined as a firm regularly engaged in the manufacture and integration of intercommunication system components, of types and ratings specified and indicated, whose products have been in satisfactory use in similar services for not less than five years.

PART 2 - PRODUCTS

2.1 INTERCOMMUNICATIONS SYSTEM

A. Basis-of-Design System: The following system by Aiphone is the basis for design.

1. Master Station: LEM-1
2. Substation:

a. Indoor Units: Contractor’s option of either LE-A or LE-D.
b. Outdoor Units: LE-DA.

B. Components:

1. Master station: Provide desk or surface wall -mounted station with the following minimum features and characteristics:

a. Volume control: Independent regulation of incoming and outgoing calls.
b. Call announcements: Momentary audible signal for incoming calls.
c. Speaker sensitivity: Minimum 40 dB EIA.
d. Hands free operation.
e. Junction box separates from master for easy wiring connections.

2. Substations: Provide with the following minimum features and characteristics:

   a. Hand-free operation with handset. When handset is on hook, built-in speaker and microphone shall be active for hand-free conversation. When handset is off hook, built-in speaker and microphone shall be silent, allowing private conversation between master and remote through handset.
   b. Speaker sensitivity: Minimum 40 dB EIA.
   c. Call announcement: Monitor lamp or recurring momentary tone.
   d. Provide substations located outside of compound perimeter wall with vandal-proof cover.

3. Power supplies: Operate on input electrical service for both 110 volts, single phase, 60 hertz and 220 volts, 50 hertz through remote or built in transformer.
4. Miscellaneous features and requirements:

   a. Provide power switch near master station to turn system on and off.
   b. Provide pilot light at master station to indicate whether the system power is on or off.
   c. Legibly and permanently label equipment to indicate function and status. Label wiring connections and terminals.

5. Wiring:

   a. Master shall include factory wired cable for connection to remote.
   b. Provide 0.65 mm (22-AWG), solid copper/tin, 5-conductors: 1-twisted pair with Mylar shielded and drain wire, and 1-twisted pair without shield, plus an overall jacket, to connect between junction boxes of Masters and Interface Amplifier.
   c. Provide 0.65 mm (22 AWG) solid copper/tin, 3-conductors: 1-twisted pair with Mylar shielded and drain wire and overall jacket, 4.8 mm outside diameter, UL type Class 2, to connect Interface Amplifier and speaker.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install audio circuits ungrounded, except as provided by single-ended amplifier input, and where grounding of unbalanced circuits is required during system tests.

B. Terminate audio cable shields at one end only, at downstream equipment (where program source is considered upstream).

C. Exercise care in wiring to avoid damage to cables and equipment.

D. Where resistors are required to terminate audio circuit, install each resistor at end of line at input to transformer or amplifier.

E. Connections:

1. Make wire joints and connections in system with rosin core solder and small soldering iron, or with approved mechanical connectors. Solder neatly, with no cold solder joints.
2. Make connections to screw type terminals with mechanically connected appropriate spade type connectors selected for particular wire size in use.
3. Crimp crimp-and-spade type connectors (including spade type connectors and insulated butt type connectors for in-line loudspeaker circuit connections) with appropriate tool.
4. Crimp spade type connectors with notch on barrel opposite seam.
5. Perform cutting and stripping of audio cables using tools recommended by cable manufacturer.

F. Take precautions to guard against electromagnetic and electrostatic hum.

G. System Installation:

1. Install equipment so that components are securely attached to substrate or structure.
2. Substations: Connections in building-exterior locations and on Public Access Area (PAA) side of teller windows shall be with tamper-resistant or concealed fasteners.
3. Master Stations: Install amplifiers, junction boxes and controller components with undercounter mounting, not visible, and installed so as not to interfere with occupant use of space.

H. FE/BR Teller Window Interface: Coordinate interface of Master Station and Substation with teller windows; see Section 085652 “Aluminum Teller Security Windows.”

3.2 FIELD QUALITY CONTROL

A. Contractor shall perform tests to verify proper operation of master station and substation at all locations for these intercoms.

END OF SECTION 275124

SECTION 275405 – CONSULAR QUEUE MANAGEMENT SYSTEM INFRASTRUCTURE AND DISPLAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for infrastructure and displays supporting consular queue management system.

1. General system infrastructure and display components such as cables, media extender, equipment cabinet, UPS, and interface components such as flat panel displays in certain locations.
2. Coordination of integration with Government-Furnished consular queue management components.

B. Related Sections include the following:

1. Division 26 Sections for conduits, outlets, and other general electrical work.
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
3. Section 260525 “Grounding and Bonding for Electrical Systems.”
4. Section 270508 “Common Work Results for Telecommunications.”
5. Section 270526 “Grounding and Bonding for Communications Systems.”
6. Section 270553 “Identification for Communications Systems.”
7. Section 271116 “Communications Cabinets and Frames” and Section 275105“Audio Systems for Consular Services” for general requirements and telecom ground busbar (TGB) requirements of consular communications cabinets.
8. Section 271123 “Communications Cable Management and Ladder Rack.”
9. Other Division 27 Sections for general requirements of distribution cabling.
10. Section 272129 “Data Communications Switches and Power Supplies” for interface with OpenNet.
11. Section 275105 “Audio Systems for Consular Services” for associated paging and intercom systems.
12. Section 337105 “Underground Ducts and Raceways” for distribution of cable to outdoor consular waiting displays and for interface with Compound Access Control (CAC) for non-staff pedestrian use.

1.2 REFERENCE STANDARDS

A. See Section 270508 “Common Work Results for Telecommunications” for commonly applicable telecommunications reference standards.

1. Each Division 27 Section may include citations to those references identified Section 270508
2. In addition, each Division 27 Section may include citations to other reference standards not listed in Section 270508

1.3 SYSTEMS DESCRIPTION

A. Queue Management System - General:

1. The work detailed within the Construction Documents is intended to meet certain requirements for performance and appearance. It is the responsibility of the Contractor to complete translation of those requirements into a systems package necessary for operational and functionally queue management system.

   a. Any item not specifically shown on Drawings or called for in Specifications, but is normally required to conform to the intent, is required to be included as part of the Work.

2. The overall Consular Affairs Queue Management (CAQM) system is produced through coordinated effort between DOS Consular Affairs (CA), DOS Post,IRM, and work included as part of this Contract. The CAQM system is connected at various points (by USG Post IRM) to OpenNet. The Government-Furnished Government-Installed (GFGI) software system used by CA is QFlow Systems by QFlow Systems, LLC. The purpose of system is to provide:

   a. Check-in of consular applicants.
   b. Customer verification.
   c. General queue management by Consular Affairs, including wait time alerts.
   d. Customer tracking by Consular Affairs. Tracking may begin at Compound Access Control (CAC) facility for non-staff pedestrian use.
   e. Customer notification visually at progressive points, and audibly in waiting areas via connection with consular paging and intercom systems; see Section 275105 “Audio Systems for Consular Services.”
   f. Real time and historical reports produced by CA for DOS Consular headquarters, using data from system.

3. Contractor-Furnished Contractor-Installed (CFCI) Components: Components to be provided as part of this Contract.

   a. Signal and power cables.
   b. [Signal and power outlets for Self-Service Ticket Issuance kiosks (STI-Kiosk).]
   c. [Signal and power outlets for outdoor consular waiting area STI-Kiosk, when applicable.]
   d. Teller window flat panel displays and brackets at each teller window station.
   e. Large flat panel displays for outdoor and indoor consular waiting areas, and for Manager’s Dashboards inside Consular office area.

f. Supports for large flat panel displays. For indoor large displays, the supports shall be brackets, except that ceiling-mounted support shall be used in the Consular Section for displays that are intended to be suspended from above. For outdoor large displays, support type shall be coordinated with environmental enclosure (e.g., display pedestal with enclosure or display bracket with enclosure).
g. Equipment cabinets as indicated on Construction Drawings. Cabinets may be shared with consular paging and teller intercoms where there are ten windows or less and with concurrence of OBO/PDCS/DE/EE; see Section 275105 "Audio Systems for Consular Windows."
h. Media extender (Tx/Rx) for HDMI, and USB signals, KVM switch, shelves, and UPS.

4. Government-Furnished Contractor-Installed (GFCI) Components: Components to be provided as part of this Contract.

a. Teller window Set-Top Boxes (STB) and brackets.
b. STI-Kiosks.

5. Government-Furnished Government-Installed (GFGI) Components: Components acquired by CA using blanket purchase agreement with ACF Technologies for "QFlow" software platform, including the following:

a. QFlow software.
b. CAQM database server and web server.
c. Visitor Reception Point (see following paragraph): IT workstation equipment, software, ticket printers, and barcode scanners.
d. HDMI Splitter.
e. Media Player computer for managing large waiting room displays.
f. STI-Kiosk PC.
g. Manager's Dashboard PC.

B. Visitor Reception Points: Locations of reception points for queueing are indicated on Construction Drawings. There are two different reception point types, an STI-kiosk or a manned reception window. Each point will include IT workstation, with associated ticket printer and barcode scanner.

1. The STI-Kiosk cabling must include three CAT6 cables within 250 ft of the CAER. Applicants/users will receive their initial ticket from ticket issuance station in this location.
2. The STI-Kiosk shall reside in the CA Waiting Area. The STI-Kiosk shall be placed close to the entrance, should not impede the flow of traffic, and shall have at least 900 mm (three feet) behind the STI-Kiosk to open the back to change printer paper.
3. STI-Kiosk Reception Point are connected via HDMI and USB cables by a CAT6 extender to the workstation in the CAER.
4. Manned Reception windows are connected to OpenNet Consular signal. Refer to Construction Drawings for number and location of these reception points.

C. Waiting Area Displays: Refer to the Part 2 Article on FLAT PANEL DISPLAYS for size and characteristics of these CFCI displays.

1. Outdoor Displays: These display(s) are intended to alert users/applicants of their turn for service so that they can approach the Consular entrance door from outdoor Consular waiting area at the appropriate time. These displays shall be provided with appropriate weather and climate protection as identified in the Construction Documents, including compatible manufactured enclosure component. The number and location of these displays will vary depending upon size and configuration of the outdoor Waiting Area and are indicated on Construction Drawings.
2. Indoor Displays: These displays are intended to alert users/applicants of their turn for service and identifying the specific window where they are being served. The number and location of these displays will vary depending upon the size and configuration of the indoor Waiting Area and are identified on Construction Drawings.
3. Indoor and Outdoor Waiting Area Large Displays are operated from consular staff side of Consular Section at dedicated Media Player computer.

D. Manager's Dashboard Displays: Refer to the Part 2 Article on FLAT PANEL DISPLAYS for size and characteristics of these CFCI displays.

1. These displays facilitate overall management of the queue by Consular staff. Displays are located within the open-office area of the Section, as well as within enclosed offices of the heads of the Section. The number and location of these displays will vary depending upon the number of staff and configuration of the Section. The displays may be a combination of wall-mounted and suspended from overhead.

E. Teller Window Stations: Customer-side and secure-side of consular teller windows are connected through separating FE/BR hardline wall.

1. Customer-Side:

a. Flat panel display and bracket for each teller window location on customer side above each station. Displays require either HDMI input or DVI input with DVI-to-HDMI converter.

2. Secure-Side:

a. Set-Top Box (STB) and Bracket: Install on STB bracket on secure side below level of teller countertop.
b. Teller IT workstation installed on teller countertop.
c. Audio functionality of consular queuing system, including intercom and paging features, is performed via connection to consular audio system.

F. Consular Queuing System Cabinets:

1. Depending upon various factors such as number of windows and layout of Consular Waiting Area, queue management and consular audio system are normally placed in

separate cabinets dedicated to Consular services. Refer to section above for GFGI items inside queuing cabinet. Consular cabinets are placed in separate Consular Affairs Equipment Room(s) (CAER) within the Consular suite. Provide addition CAER if CA windows occupy more than one floors. Location and number of cabinet(s) is project-specific. Consolidate queue management system with consular audio system into single cabinet if there are less than four windows and indicated on Construction Drawings.

2. These cabinets serve as the central point for routing signal cable for indoor and outdoor large Waiting Area displays. Waiting Area displays must be within 75 meters (250 ft) of these system cabinets.
3. See Section 271116 “Communications Cabinets and Frames” and Section 275105“Audio Systems for Consular Services” for most requirements associated with these cabinets.
4. In addition to media PC, managers dashboards, and kiosk connections, provide a minimum of (6) OpenNet cables from the nearest TR to each CAER Cabinet. Terminate OpenNet cables on a patch panel.
5. Provide 4RU of rack space per waiting area Media PC. Provide (1) rack amount shelf per media PC. Provide (1) OpenNet cable from the nearest TR for each media PC. Terminate OpenNet cables on a patch panel. Coordinate with OBO/DE/EE/TEL and CA/CAEX to determine the number and location of waiting areas.
6. Provide 4RU rack space for each kiosk. 4RU: Provide (1) OpenNet cable from the nearest TR for each kiosk PC. Terminate OpenNet cables on a patch panel. Coordinate with OBO/DE/EE/TEL and CA/CAEX to determine the number of waiting areas.
7. Provide 4RU of rack space per Managers Dashboard PC. Provide (1) rack amount shelf per media PC. Provide (1) OpenNet cable from the nearest TR for each media PC. Terminate OpenNet cables on a patch panel. Coordinate with OBO/DE/EE/TEL and CA/CAEX to determine the number and location of Managers Dashboards.

G. Consular Server Cabinets:

1. Many items placed in these cabinets, such as EQM Database Servers, are GFGI items. These cabinets are typically placed in the Joint-Unclassified Computer Room (JUCR). Refer to the Construction Drawings for cabinet locations and layout of each cabinet.
2. See Section 271116 “Communications Cabinets and Frames” and Section 275105 “Audio Systems for Consular Services” for most requirements associated with these cabinets.
3. Provide a minimum of (6) OpenNet cables from the nearest TR to each Consular Server Cabinet. Terminate OpenNet cables on a patch panel.

H. System Power: Provide rack-mounted UPS for queue management system. Size UPS to support all queuing equipment, CFCI and GFGI at full load for 15 minutes backup.

I. Electrical Characteristics: System equipment shall operate on 120 to 240 VAC at 50/60 Hz as appropriate to the host country.

J. Structural Performance: Using appropriate fastenings and supports, adequately support system infrastructure and equipment with safety factor of at least three.

1.4 SUBMITTALS

A. General: Technical submittals (e.g., product data, shop drawings, schedules) associated with this Section shall be submitted together with the submittals for general Division 27 telecommunications sections to facilitate coordination of systems.

B. Coordinate timing and content of submittals with those for Section 275105 "Audio Systems for Consular Services."

C. Product Data:

1. Manufacturer's product data sheets for all materials and equipment. Mark each product data sheet to show applicable choices and options. Sheets containing more than one device or component model number shall be clearly marked to delineate items included in the work.
2. Accessories, including equipment racks, and trim components.
3. Provide one additional copy of sheets for displays and display brackets to facilitate review by Consular Affairs (CA).

D. Shop Drawings:

1. If not included in submittal for consular audio system, submit detailed plan views and elevations of relevant equipment rooms that show raceway, sleeves, cable tray, cable paths, equipment cabinets, termination blocks, power receptacles, and grounding bus bars and required clear space.
2. Consistent with schematic installation indicated in Construction Drawings, detail installation of equipment and cable layout to further enhance operational efficiency and overall aesthetic factors.
3. Cable run sheets that denote cable type, signal type, termination type, cable number designation, start point, and device endpoint.
4. Floor-plan drawings indicating device locations with device legends. Indicate locations of wall plates, and jack and outlet configuration.
5. Schematic block diagrams for consular queue management system that shows equipment, interconnects, data flow, and other pertinent information, and identifies GFGI and CFCI components.
6. Wiring diagrams for each subsystem that defines the interconnection of all inputs and outputs for system equipment.
7. Provide STI-Kiosk floor mounting template.

E. Plans and elevations of consular queue management equipment cabinet(s) quantifying all equipment to be mounted in each.

F. Qualifications:

1. Queue Management System Subcontractor Qualifications:

a. Subcontractor Team Member Resumes: Submit resumes for key subcontractor team members, indicating past similar A/V project experience.

G. Operations and Maintenance Manuals: Manuals shall apply for CFCI equipment.

1.5 QUALITY ASSURANCE

A. Work specified in this Section shall be responsibility of single systems contractor.

B. Single Source: Any given item for this system shall be the product of one manufacturer throughout the Project; multiple manufacturers of any one item is not permitted unless specifically noted otherwise.

C. Original Equipment Manufacturer: All accessories, including rack-mounting hardware and power supplies, shall be obtained from original equipment manufacturer. Unless otherwise noted or specified, third-party accessories are not permitted.

D. Basis of Design: For certain components of the consular queue management system, specific manufacturers and models have been identified as “Basis of Design” These manufacturers and models are listed for example purposes. Contractor may provide other manufacturers and models which meet or exceed specified functional, technical, and service support requirements.

E. Subcontractor Qualifications: Actively involved for at least five years in projects involving display technology of similar magnitude and scope.

F. Comply with requirements of the OBO Electrical Code (NFPA 70, “National Electrical Code” as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Space will not be provided at project site for purpose of pre-assembly and testing. Any required pre-assembly and testing shall be conducted at facility supplied by Contractor.

1.7 COORDINATION

A. Coordinate with general telecommunications and A/V design to determine that appropriate raceways are in place.

B. Coordinate with related trades to schedule the Work and ensure complete and integrated installation.

C. Coordinate with Project Director/COR for work of this Section in relation to Government-Furnished components

D. Coordinate with Project Director/COR for technology updates of Contractor-Furnished and Government-Furnished system components after notice to proceed for construction.

1.8 WARRANTY

A. The one-year project warranty commencing at the date of Substantial Completion shall include replacement of flat panel displays for any display not able to be repaired in the field.. Replacement equipment shall be on site and operational within two weeks of the component failure.

1.9 CONTRACTOR-FURNISHED GOVERNMENT-INSTALLED (CFGI) MATERIAL

A. Furnish the materials identified below as CFGI materials. Most of this material will be installed by the Government as part of the Project, though some of it as determined by the Government will be kept by the Government as extra material.

1. Patch Cords:

a. General:

1) Electrical performance of patch cords shall equal electrical performance of cable used within system being patched interconnected, or cross-connected.
2) Same manufacturer furnishing cable shall furnish patch cords.
3) Furnish cords in box.

b. Streaming Device: Furnish one 0.45 m (1-1/2 ft) yellow patch cord for each streaming device.

c. CAER Cabinet: Furnish one 1-meter RG6 coax patch cord with each cabinet for future connectivity. Furnish OpenNet patch cables per Specification 271505. Furnish all HDMI and USB patch cables required for a complete and functional system and where specified within this document.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE FOR QUEUE MANAGEMENT SYSTEM

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden, Inc.
2. Commscope, Inc.
3. West Penn Wire.

B. Cable Jacket: Plenum-rated.

C. Cable Type for Queue Management System:

1. Fiber Optic Cable: 50/125 micron OM4.
2. CAT6 cable.
3. HDMI cable.
4. USB cable.
5. Shielded CAT6 if recommended by hardware manufacturer.

D. Cable Accessories:

1. HDMI Converters/Extenders. Match resolution of connected monitors.

a. Basis of Design for Short Range: Crestron, Extron, or ZeeVee HDMI Extender over CAT6 with IR range extenders.
b. Basis of Design for Long Range: Crestron, Extron, or ZeeVee Long Range HDMI Extender over multimode fiber with IR/RS-232 and Ethernet for longer distances and outdoor displays
c. Standards: HDMI 1.3a and HDCP compliant.
d. Provides independent DDC channel.
e. Bandwidth: 10.2 Gb/s.
f. Distance: 70 m (230 feet) for 1080p.
g. Transmitter: V-Input shall be 1x HDMI (female, 19 pin). Output shall be 2x RJ-45 IR socket.
h. Power Supply: Output shall be 5V, DC, 4A. Input shall be 100-240 VAC, 50/60 Hz, 0.8A. Power consumption shall be 10 Watts max.
i. Receiver: Output shall be 1x HDMI (female, 19-pin). Input shall be 2x RJ-45.

2. USB Converters/Extenders: For each of Kiosk provide the following:

a. Basis of Design: USB2004EXTV by StarTech, ICRON (1) per kiosk
b. Patch Cables: USB 2.0 < 10m, USB 3.0/3.1 Gen1) < 5m, USB 3.1 Gen2 < 1m.

E. Receptacles: NEMA 6-20R or local standard.

F. KVM switch: shall be rack mounted, have HDMI and DVI input, with USB front input for card reader.

1. Basis of Design: Raritan T1700-LED.

2.2 FLAT PANEL DISPLAYS

A. General:

1. Basis of Design: Subject to compliance with requirements, provide products comparable to the models identified below for each application.
2. Displays shall be compatible with local voltage.
3. Displays shall be capable of being powered off via remote control.
4. Displays shall have HDMI input.
5. Displays shall be minimum of 4K resolution with commercial rating depending on use case.

B. Consular Window (Teller) Displays:

1. Basis of Design: Minimum of 800 mm (32 inch) display.
2. Approximate Size: 800 mm (32 inch) viewable display screen.
3. Minimum of 4K resolution.
4. VESA-mountable design for flexible mounting and tilting.
5. Built-in tuner and speakers on unit.

C. Indoor **[and Outdoor]** Consular Waiting Area Displays: Size as indicated on Construction Drawings:

1. Basis of Design: NEC displays.
2. Approximate Size: 1150-1375 mm (46-55 inches).
3. Minimum of 4K resolution.
4. VESA-mountable design for flexible mounting options and tilting.
5. Built-in tuner and speakers on unit and suitable for functioning.

D. Manager's Dashboard Displays:

1. Basis of Design: NEC 558 model or equivalent.
2. Approximate Size: Size as indicated on Construction Drawings. Baseline size of 1150-1375mm (46-55 inches).
3. Minimum of 4K resolution.
4. VESA-mountable design for flexible mounting options and tilting.
5. HDMI input.
6. Built-in tuner and speakers on unit and suitable for functioning.

2.3 INDOOR FLAT PANEL DISPLAY BRACKETS

A. Brackets shall conform to VESA standard.

B. Bracket shall permit downward tilting.

C. Brackets shall be for wall or overhead suspended mounting as indicated on Construction Drawings.

D. Weight Capacity: Coordinate with size of display.

2.4 [OUTDOOR FLAT PANEL DISPLAY ENCLOSURE AND SUPPORT

A. [Basis of Design for Display Enclosure: [Peerless FPE47F-S (cooling only)] [FPE47H-S (heating and cooling)].

1. Size for display.
2. Corrosion-resistant construction.
3. Security hardware
4. Shatter-resistant glass window.

B. Basis of Design for Display Pedestal: Peerless FPEPM-06.

1. Height: 1800 mm (6 ft).
2. Corrosion-resistant construction.
3. Tilt setting from 0 to 15 degrees.
4. Security hardware.]

2.5 CONSULAR QUEUING EQUIPMENT CABINETS

A. General: Refer to Section 271116 “Communications Cabinets and Frames” for general requirements for cabinet serving consular systems.

B. AC Power Uninterruptible Power Supply (UPS): Provide rack-mounted UPS power for queue management system. Size UPS to support all queuing equipment, CFCI and GFGI, inside queuing cabinet at full load for 15 minutes backup.

C. Configuration: As detailed on Construction Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas to receive the work and conditions under which the work will be performed. Remedy conditions detrimental to proper completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. It is the responsibility of Contractor to confirm all dimensions and locations related to installation of system in the Work.

3.2 GENERAL INSTALLATION

A. Scope of System Installation: Installation includes fastening system components and equipment to walls, floors, ceilings, counters or other structures as indicated on Construction Drawings or as otherwise required; interconnecting wiring of the system components, alignment and adjustment of system components, and related installation necessary to result in complete and fully operational system.

1. Power outlets, penetrations, and conduits shall be installed by electrical subcontractor.
2. Refer to other Division 27 Sections on communications for general installation standards.
3. Detail of equipment and cable layout shall not only recognize operational efficiency, but also overall aesthetic factors.
4. Cable Application: On queue management system schematic diagrams in Construction Drawings, signal type is indicated at equipment input or output.

    a. Signal cable between teller set-top-box (STB) and teller window flat panel display.
    b. Signal cable between Indoor Consular Waiting large flat panel display and Consular Equipment Room cabinet.
    c. Signal cable between Indoor STI-Kiosks and the Consular Equipment Room cabinet.
    d. Signal cable between STI-Kiosks and OpenNet connection.
    e. Signal cable between Outdoor Consular Waiting and Consular Equipment Room cabinet.

B. Visitors Reception Points:

1. Outlets: Install four duplex power outlets or one quad power outlet at each reception point. Provide NEMA 6-20R receptacles.
2. OpenNet Connections: Provide Cat 6 connections at each reception point to CAER: Kiosks (Three-OpenNet connections), Manager's dashboards (Two-OpenNet connections). Coordinate with OBO/PDCS/DE/EE and Consular Affairs (CA) for exact locations. Cable color identification shall conform to OBO standards for UTP horizontal distribution in accordance with Section 270553 "Identification for Communications Systems." Use RJ-45 terminations.
3. Kiosk/Dashboard outlets: provide three CAT6 green color to each Kiosk location. Terminate cables with RJ-45 termination at the faceplate and on RJ-45 patch panel at the CAER.

C. Displays:

1. General – Flat Panel Large Displays: Install with sufficient space behind displays to facilitate placing HDMI components and TV power cord adaptors.
2. Indoor Flat Panel Large Displays: Install panel in bracket at wall, column cover, or ceiling, as indicated on Construction Drawings, using bracket size and configuration suitable for display and location.
3. Outdoor Flat Panel Displays: Install within manufactured enclosure component on support structure or bracket as indicated on Construction Drawings. Install cable in 50-100 mm

below-grade conduit from Consular equipment room to locations of large flat displays in outdoor Consular waiting area. See Division 26 sections for installation of conduit outside the building.

4. Power Outlets: Refer to Division 26 Sections for general requirements. Outdoor outlets shall be ground-fault circuit interrupt type.

D. Teller Window Station:

1. Customer Side:

a. Flat Panel Display and Bracket: Install wall-mount flat panel display bracket and flat panel display at each window; locate as indicated on Construction Drawings. Place bracket approximately 150 mm above bottom of teller window booth wall opening. Center bracket installation with associated teller window. Coordinate bracket elevation with electrical and signal outlet installation, and place so that outlets are not visible, and that outlets do not outlets do not impede ability of bracket to tilt display.
b. Provide black 450 mm (18 inch) HDMI connector cable with HDMI connectors at each end. Terminate cable in accordance with ANSI/TIA/EIA 568.2. Neatly coil HDMI patch cable, with radius bend no less than manufacturer's recommended minimum.
c. Power Outlets: Install receptacles next to flat panel signal, and position behind displays to generally conceal from view. If using two outlets, install in uniform manner with same elevation and equal distance between outlets in all teller window display locations.

2. Secure (Teller) Side: Install system components below countertop:

a. Install one Set-Top Box (STB) and bracket under each teller countertop as indicated on Construction Drawings.
b. Install STB within 300 mm (1 ft) of associated duplex power receptacle, OpenNet port, and HDMI Wall Plate. USG will connect STB to OpenNet. Group all the devices and align them on their centerlines horizontally.
c. Equipment Power Outlet: One 16 or 20A receptacle.
d. Workstation Outlet: Provide one additional CAT6 (orange) to the typical workstation outlet at Consular officer desk to support STB.
e. Orange: DOS OpenNet SBU data.
f. Label telecom ports and wall jacks in accordance with Section 270553 "Identification for Communications Systems."

3. Connecting Components: Connect STB with customer-side window flat panel display.

a. Provide connection through hardline walls using penetration protection on customer side as required; refer to Construction Drawings. Use the following cables for the connection:

1) Two solid conductor CAT6 cables. Install HDMI faceplate at each end of CAT6 cables using Crestron, Extron, or ZeeVee HDMI over CAT6 wall plate or equivalent.

E. Consular Equipment Cabinets:

1. Refer to Division 27 Sections for general installation requirements.
2. Install minimum six OpenNet drops from nearest TR to each CAER and JUCR Queuing cabinet. Install additional OpenNet connections as detailed in this specification. Quantity of OpenNet cables shall be increased based on quantity of Kiosks, Manager's Dashboard, and Media Player PC.
3. Terminate home run cables from Consular Waiting large displays to queuing cabinet on one 24/48 port CAT6 patch panel.
4. Install black one-meter HDMI connector cables, with factory-installed HDMI connectors at each end.
5. Install CAT6 to HDMI converter/extender within cabinet.
6. Install one horizontal cable TV RG6 cable from Telecom Room (TR) TV distribution field and terminate within this cabinet.
7. Install one 1-meter RG6 coax patch cord within cabinet for future connectivity.
8. Install in configuration identified in Construction Drawings.
9. Install Shelves to support CFCI media extender and GFGI equipment.
10. Install UPS.

F. CAQM Hardware Worksheet:

1. The system design shall comply with the hardware worksheet:

Component	GFGI	GFCI	CFCI	Requires UPS
Core Application				
Servers	x			
Software	x			
Hardware				
CAQM Large Monitors/TVs			x	
CAQM Large Monitors/TV Brackets			x	
Graphics Card				
CAQM Manager Dashboard Monitors				
CAQM Manager Dashboard TVs			x	
CAQM Manager Dashboard TV Brackets			x	
Teller Window Displays			x	
HDMI Splitter- DA			x	x
STI - Kiosks*		x		
STI - 508 Compliant Kiosks***		x		
USB Extenders			x	x
HDMI Extender Kit (Tx and Rx)			x	x
KVM (HDMI Compatible)			x	x
STI - Kiosk PC	x			x
MGR Dashboard PC outside CAER	x			
MGR Dashboard PC in CAER				x
Media PCs	x			x
Set Top Boxes (with brackets)*		x		
Thermal Printers	x			
Infrastructure				
Cat 6 Patch Cables			x	
HDMI Wall Plates			x	
HDMI Cables			x	
Power			x	
Rack RUs			x	
Wall/Floor Boxes (for kiosk installs only)			x	

3.3 GROUNDING OF CONSULAR QUEUE MANAGEMENT SYSTEM

A. General: Comply with Chapter 2 of the OBO Electrical Code. Refer to Section 260525 “Grounding and Bonding for Electrical Systems” and Section 270526 “Grounding and Bonding for Communications Systems.”

3.4 FIELD QUALITY CONTROL

A. After installation of cable, Queue Management System Infrastructure installer shall test cable prior to installation of displays and shall perform repairs or replacements until testing is successful.

B. After displays are mounted, infrastructure installer shall test continuity of Set-Top Box (STB) with teller window displays; blue display should show if continuity is present.

C. After installation of Government-Furnished Government-Installed (GFGI) components of queue management system, Government will perform testing of overall system, including cabling, all equipment incorporated in system, and all software associated with system, and will perform adjustments necessary for operational queue management system.

3.5 CLEANING AND PROTECTION

A. Clean up and repair all areas affected by this work. Protect exposed surfaces with materials that are easily removed without marring finishes.

3.6 DEMONSTRATION

A. Comply with Division 01, Section 017905 “Demonstration and Training” for general requirements of demonstration and training documentation.

B. The manufacturer’s representative or approved installing subcontractor shall provide ‘hands-on’ training sessions for the Government O&M personnel.

1. Schedule as follows:

   a. Classroom Instruction: Two (2) hours.
   b. Field Demonstration: Two (2) hours.

C. Training shall cover the following topics:

1. General purpose of this system or equipment (design intent).
2. Maintenance and repair including manufacturer’s data within the O&M manual (service sources, spare parts inventory, special tools, etc.).
3. Common troubleshooting issues and methods, control system warnings and error messages.
4. Monitoring requirements with appropriate/specified equipment and diagnostic analysis.

END OF SECTION 275405

SECTION 280508 – COMMON WORK RESULTS FOR TECHNICAL SECURITY SYSTEMS (TSS)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general requirements for full Technical Security System (TSS) and interaction of TSS with other building systems. In addition, the following technical security support system elements which serve a variety of TSS sub-systems are included in this Section:

1. TSS Itemizer supplies freezer.
2. TSS equipment racks.
3. TSS Uninterruptible Power Supplies (UPS).
4. TSS raceways and boxes.
5. TSS conduit identification.
6. TSS panelboards
7. TSS wiring devices.
8. TSS enclosed switches and circuit breakers.

B. Technical Security Sub-Systems: The requirements for individual TSS sub-systems are included in the sections identified below. Requirements for technical security support system elements (e.g., cable and power supplies) associated with each of these TSS sub-systems are included in each of these sections as applicable. Each TSS sub-systems is described in the SUMMARY Article of each of these sections:

1. Section 087155 “Security Door Hardware” for door closers at security doors.
2. Section 260508 “Common Work Results for Electrical, Communications, and Electronic Safety.”
3. Section 260525 “Grounding and Bonding for Electrical Systems.”
4. Section 262417 “Panelboards.”
5. Section 262725 “Wiring Devices.”
6. Section 270508 “Common Work Results for Telecommunications.”
7. Section 281005 “Technical Security Access Systems.”
8. Section 282305 “Security Video System (SVS).”
9. Section 283105 “Technical Security Intrusion Detection Systems.”
10. Section 283325 “TSS Intercommunications System.”
11. Section 283337 “Technical Security Duress Systems.”
12. Section 284705 “Mass Notification Systems.”
13. Section 285115 “Security Management System Enterprise (SMSe).”
14. Applicable Division 32 OBO Standards Sections on active vehicle barriers.
15. Section 337105 “Underground Ducts and Raceways.”

C. Standalone Equipment: Explosives detection equipment such as X-ray machines and Itemisers units are standalone items (thus labeled “equipment”) which are covered in Section 281805

"Technical Security Access Equipment." These are in contrast to access and detection "systems" that are not standalone, which are covered in Section 281005 Technical Security Access Systems and Section 283105 "Technical Security Intrusion Detection Systems." Technical security access "equipment" are not covered by provisions of this Section, " except in relation to use of "TSS QC Checklists" described in Article on QUALITY ASSURANCE, and for listing of DS approved products described in the GENERAL Article in Part 2 of this Section.

D. General TSS Support System Elements: General requirements for TSS support systems are further identified in Division 26.

E. PAA/Lobby Special System: The requirements for a special TSS system related to lobby areas will be identified on a project-specific basis.

1.2 SUBMITTALS

A. General: Refer to individual technical security system specification sections for additional submittals.

B. Product Data: Include components, furnished specialties, dimensions, finishes, and accessories for items identified in this Section. Submit to Project Director/COR for acceptance based upon OBO/CFSM/SM/TSB review prior to purchase and secure shipment of these components.

C. Shop Drawings: Details assemblies of standard components that are custom assembled for specific application on this Project. Refer to related TSS Sections for specific sub-system requirements.

1. Functional Block Diagram: Show single-line interconnections between all TSS subsystems identified in various TSS subsystem Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify control interface devices and media to be used. Describe characteristics of network and other data communication lines.
2. TSS Panelboard Drawings: For each panelboard, provide drawing information.
3. TSS Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
4. TSS Enclosed Switches and Circuit Breakers: Include diagram of power, signal, and control wiring.
5. Room Elevations: EC Room, Sub-EC Rooms, and TSS Riser Room elevations.

D. Qualification Data:

1. TSS Integrator Qualifications.
2. Technical Qualifications for each TSS subsystem Installer.
3. Testing Agency Qualifications for TSS panelboards and for TSS enclosed switches and circuit breakers.
4. Manufacturer Seismic Qualification Certification: Submit certification.

E. Contractor QC Pre-Check Certification:

1. Certification that each TSS sub-system pretest and check by Contractor against "TSS QC Checklists" identified in Article on QUALITY ASSURANCE, and against "Contractor Accreditation Worksheet" has been 100 percent successful.

F. Additional Field Quality-Control Test Reports. Submit to Project Director/COR for use in Accreditation review.

1. TSS Panelboards:

a. Test procedures used.
b. Test results that comply with requirements.
c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

2. TSS Wiring Devices.

a. Fiber optic cable.
b. CAT 6 cable.

G. Operations and Maintenance Data.

H. Barcode Matrix: Submit in accordance with Article on FIELD QUALITY CONTROL.

1.3 QUALITY ASSURANCE

A. TSS Integrator Qualifications: An experienced supplier and installer with minimum 10 years of experience with OBO projects, and who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

B. SVS Installation Supervision: During duration of security video system (SVS) installation, work must be under direct supervision of IP Network Systems Engineer for SVS system.

C. Comply with the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO.

1. Electrical Components, Devices, and Accessories: For general electrical items associated with TSS work, listed and labeled in accordance with Chapter 1 of the OBO Electrical Code by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE, and marked for intended use.

D. The Government will perform source and field quality assurance for all TSS sub-systems, including for portions identified in Division 26, 27 and 28 sections, in accordance with separate

contract attachments "TSS QC Checklists," and "Contractor Accreditation Worksheet." Contractor is responsible for performing quality control, including pre-testing and pre-checking of TSS sub-systems to ensure that each is at least 90 percent ready at the time of QA by the Government.

E. TSS Identification: In accordance with Chapter 2 of the OBO Electrical Code. Same requirements as for general electrical identification in Division 26 Section on identification for electrical systems.

F. TSS Panelboards:

1. Testing Agency Qualifications: Refer to qualification requirements in Section 262417 "Panelboards."
2. Comply with NEMA PB 1.

1.4 COORDINATION

A. Sequence, coordinate, and integrate installing TSS materials and equipment for efficient flow of the Work.

B. Installation of signal and audio pull boxes must be coordinated with other disciplines for accessibility by ladder during installation and future maintenance.

C. Where TSS devices are applied to field-finished surfaces, coordinate installation of devices with completion of finished surface.

D. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

E. Consular/Pedestrian-Only CAC: Provide rack at security screening area when guard booth is not available. Coordinate millwork to accommodate TSS racks.

F. Provide coordination as required in the following Sections:

1. Division 26 Section on identification for electrical systems.
2. Section 262417 "Panelboards."
3. Division 26 Section on enclosed switches and circuit breakers.

1.5 DELIVERY AND STORAGE

A. Equipment delivered must be stored with protection from the weather, humidity, and temperature variation, dirt, and dust, or other contaminants.

B. Store and protect equipment identified for installation within Controlled Access Area (CAA) in the Secure Storage Areas as identified in Division 01 sections.

1.6 PROJECT CONDITIONS

A. Post 1 and Main EC Room: Do not install technical security systems and equipment located in either room until the following are in place:

1. Design temperature and humidity can be maintained using either temporary or final HVAC equipment.
2. Continuous temporary or permanent power is available for the installed systems in accordance with the requirements of each system.
3. Reasonably free of dirt and dust.

B. TSS Panelboards: Conform to requirements of Section 262417 “Panelboards.”

C. TSS Enclosed Switches and Circuit Breakers: Conform to requirements of Division 26 Section on enclosed switches and circuit breakers.

1.7 EXTRA MATERIALS AND INFRASTRUCTURE

A. General: Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. TSS Panelboards:

1. Keys: Six spares of each type of panelboard cabinet lock.

C. TSS Enclosed Switches and Circuit Breakers:

1. Spares: For the following:

a. Potential Transformer Fuses: Six.
b. Control-Power Fuses: Six.
c. Fuses and Fusible Devices for Fused Circuit Breakers: Six.
d. Fuses for Fused Switches: Six.
e. Fuses for Fused Power-Circuit Devices: Six.

2. Spare Indicating Lights: Six of each type installed.
3. Spare Fiber Optics:

a. Provide 12-strand /50 Micron Multimode fiber cables between the Main EC room and Sub-EC rooms located in all outbuildings.
b. Provide patch panel at each location. Fiber must be terminated and tested.

4. Infrastructure Dedicated for Future Access Denial System (ADS): Conduit must be labeled "Dedicated for Future ADS. Other Uses are not permitted."

   a. Conduit must be selected that is able to accommodate minimum static or no load-bending radius for multi-mode fiber optic cabling. Install pull string in all conduit runs:
   b. Provide building(s) interior with two 50mm conduits from a wall mounted junction box located in Main EC Room, and terminate conduit at lockable junction box that is sized accordingly. Locate junction boxes 100mm above finished ceiling and below other services with access (via panels, acoustical tiles, etc.) in the following areas:

      1) NOB/NOX Main Lobby.
      2) Consular Section Waiting Area.
      3) NOB/NOX Service Entrance Screening Area.

   c. Provide compound site with two 50mm conduits from a wall mounted junction box located in the Main EC Room that is sized accordingly. Conduit must terminate to a junction box located on wall of the following rooms:

      1) Each CAC Sub-EC Room.

PART 2 - PRODUCTS

2.1 GENERAL

A. Approved Products: All technical security products provided in this Section and other TSS subsystem Sections must be approved by Diplomatic Security (DS). See separate contract attachment, "DS TSS Equipment List" for a partial listing of products that have been approved for general use in DOS overseas facilities.

B. Refer to individual technical security system specification sections for signal support and power supply requirements.

C. The use of laptop computer will be necessary to implement installation when programming the TSS controllers. Contractor must provide suitable laptop for this purpose, and laptop will remain property of Government. Control of laptop must be in accordance with direction of Project Director/COR.

2.2 TSS ITEMIZER SUPPLIES FREEZER

A. Freezer Features:

1. Capacity: 130 L (30 gallons).

2. Cabinet Dimensions: Approximately 600 mm W x 600 mm D x 850 mm H.
3. Listed to NSF-7 commercial standards.
4. Stainless steel door with factory-installed lock, latch, and handle.
5. Sealed back.
6. Adjustable chrome shelves.
7. Frost-free operation with fan-forced cooling.
8. Digital thermostat.
9. Open door alarm.
10. High temperature alarm.
11. Recessed LED lighting.
12. Right angle plug; facilitates plugging unit flush against wall socket.
13. Two keys.

B. Basis of Design: Summit Appliances Model SCFF53BSS.

2.3 TECHNICAL SECURITY SUPPORT SYSTEMS

A. Refer to individual technical security system specification sections for signal support and power supply requirements.

B. TSS Equipment Racks:

1. Post 1 Racks: Provide 475 mm (19 inch) wide by 600 mm (24 inch) deep by 1.8 mm (14 gauge) thick EIA equipment racks to house most of TSS control equipment in operational configuration. Coordinate rack layout with Post 1 layout. Provide an unobstructed view of the lobby screening and controlled doors, the racks will not extend above countertop. Provide arrangement as follows:

   a. Short Rack for equipment which requires constant attention, such as door control modules, SVS monitors, etc. These racks will be located under countertop.
   b. Tall Racks to house the following:

      1) Remaining security video system (SVS) monitors.
      2) Vehicle barrier and gate override controls.
      3) Door control “racks.”
      4) Intrusion Detection System (IDS) annunciators and receivers.
      5) Emergency Notification System (ENS) control panels and microphone.
      6) Annunciation panels for Imminent Danger Notification System (IDNS) IDNS and duress buttons.

   c. SMSe Workstation.

2. Main EC Room: Provide three 600 mm (24 inch) wide by 800 mm (32 inch) deep by 1.8 mm (14 gauge) thick EIA equipment rack; components housed in these racks include, but are not limited to, the following:

a. SMSe network controls
b. HDVS switching and recording equipment.

3. Safe Haven or Safe Area: Unless otherwise indicated, provide two tall EIA rack to contain controls identified as EAP Rack.
4. Service and Main CAC: Provide racks in guard posts.
5. Consular/Pedestrian-Only CAC: Provide rack in guard post or at security screening area when guard booth is not present.
6. NOX Guard Post: Provide 475 mm (19 inch) wide by 600 mm (24 inch) deep by 1.8 mm (14 gauge) thick EIA equipment racks.

C. Uninterruptible Power Supply (UPS): Provide units to support TSS.

2.4 TSS RACEWAYS AND BOXES

A. TSS Pull Boxes and Junction Boxes:

1. Provide pull boxes located less than 3 meters above floor in Public Access Area spaces with lockable covers or tamper-proof screws.
2. Provide boxes with 25 mm minimum knockouts for TSS equipment.

B. TSS Cabinets:

1. TSS EC is a low voltage (< 48 volts) interface cabinet.
2. Provide steel blank panel insert and locking handle.

C. TSS DIN Rail Terminals: Install in electrical cabinets located in Main EC Room and Sub-EC Rooms. Use these terminals to terminate cables in these cabinets in lieu of screw-type barrier strips to facilitate space utilization.

2.5 TSS IDENTIFICATION FOR ELECTRICAL COMPONENTS

A. Refer to Division 26 Section on identification for electrical systems for general product requirements.

2.6 TSS PANELBOARDS

A. Refer to Section 262417 “Panelboards” for general definitions and product requirements.

B. Fabricate TSS panelboards with appropriate buss connections to provide single phase (Line, Neutral, and Ground) distribution section. This includes covers, labeling, and buss connection for panelboards.

C. TSS Multi-Tap Connector:

1. DS-Approved Equipment: Burndy BIBD2/03MT UNITAP Connector.
2. Characteristics:

a. Length: 90 mm (3-1/2 inches).
b. Width: 40 mm (1-1/2 inches).
c. Height: 38 mm (1-1/2 inches).
d. Number of Ports: Three (two-sided entry).
e. Stranded Copper Wire Range: 12 mm2 – 70 mm2.
f. Hex Key: 3/16 SAE.
g. Torque Specification: 13.5 nM (120 in.lb.).
h. Insulation: Clear Plastisol, 600 V rating.

2.7 WIRING DEVICES

A. Refer to Section 262725 “Wiring Devices” for general definitions and product requirements.

2.8 TSS ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Refer to Division 26 Section on enclosed switches and circuit breakers for general definitions and product requirements.

B. Uninterruptible Power System (UPS) Bypass Switch: Provide UPS bypass switch to facilitate providing power to Panel ‘EU” in event of UPS failure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, clearance requirements, service rough-ins, and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Verify that all pull boxes are accessible without obstructions to installers of technical security systems; access via a ladder is permissible.
3. TSS Itemizer Supplies Freezer: Ensure adequate clearance and proper electrical outlet type and location.

B. Verify that proper security conditions are present in area. Consult with Project Director/COR and Site Security Manager to determine readiness of spaces and systems to receive technical security systems and equipment.

3.2 INSTALLATION - GENERAL

A. Set security equipment level, plumb, properly aligned, and securely in place. Anchor as required for secure operation.

B. Install systems as indicated on TSS drawings.

C. Run cables continuously and without splices between equipment and nearest EC Room.

D. Make final signal and control connections at terminal equipment and at nearest EC Room.

E. Terminate unused alarm zones on low-level alarm system with resistors in Main EC Room.

F. Only TSS equipment, power, and cabling may be placed in Main EC Room. No other conduits serving other systems are permitted to pass through Main EC Room.

G. Place power supplies for TSS equipment which require low voltage AC/DC in Main EC Room, Sub-EC Room, or TSS riser room associated with building housing equipment.

H. Label power supplies as to their system and function.

I. The placement of low-voltage power supplies must consider the voltage drop due to cable loss. It may be more practical to install door control or SVS power supplies close to the equipment loads. Where distance impedes the ability to use the Main EC Room, use Sub-EC Rooms to contain interface points, and other TSS infrastructure.

J. Refer to separate contract attachment “Technical Security (TS) Application Guidelines” for the systems identified below for detailed installation instructions and adjustments to manufactured systems.

1. Fiber Optic Applications.
2. DS Power System.
3. APC Symmetra LX UPS.

3.3 INSTALLATION – TSS RACEWAYS AND BOXES

A. Refer to Division 26 Section on raceways and boxes for general execution requirements.

B. Outdoor Building Hardline:

1. Above Grade Installations: Intermediate metal conduit (IMC), rigid metallic conduit (RMC), or liquid-tight flexible metal conduit (LFMC).
2. Below Grade Installations:

    a. Rigid non-metallic conduit (RNC) such as Schedule 40 poly vinyl chloride (PVC).
    b. Inside diameter must minimum 50 mm (2 inches).
    c. Where using non-metallic conduit below grade, make transition to metallic conduit by using metallic coupling when leaving conduction or duct bank to continue above grade.
    d. Install in accordance with provisions of Chapters 1 and 3 of the OBO Electrical Code related to underground ducts and raceways, including for hand holes and manholes. Utilize "ruggedized cabling."

C. Indoor TSS:

1. Inside Building Hardline: Use one of the following:

    a. FMC with 27 mm min. I.D. and 2 meters max. length. Do not use for wiring of TSS components in door frames.
    b. RMC, IMC, or EMT.

D. General:

1. TSS signal conductors must not share same conduit, handholes, electrical cabinets, or junction boxes with power conductors.
2. Non-security signal and power conductors must not be installed in conduits used for TSS signal and power conductors.

    a. The only exception is for chemical dispensing system.

3. All TSS cabling in Post 1 must come from Main EC Room.
4. Cabling between main compound building and outlying buildings must run to Sub-EC in outlying buildings and then connect to appropriate guard location for each building.
5. Use cable management devices such as cable hangers and wire ducts to ensure facilitate orderly and clear appearance.
6. Conductors Serving Devices: To maintain aesthetic, use only plastic tubing or raceway for these conductors. Place devices and junction boxes to limit length of conductors between them to 1000 mm (39 inches).
7. Refer to separate contract attachment "Technical Security (TS) Application Guidelines" for the systems identified below for detailed installation instructions and adjustments to manufactured systems.

    a. DIN Rail.
    b. Network infrastructure.
    c. Deployment Document TSS Network Infrastructure.

E. Conduit:

1. At transitions from below grade to above grade conduit routing, use metallic elbows at least 3 meters outside of building wall to change from below grade RNC to above grade metallic conduit.
2. Where transiting building hardline, physically protect conduit be means such as embedding conduit in concrete.
3. Conduit above ceiling may be surface mounted.
4. Route TSS conduits to minimize conduits in areas external to building hardline.

F. Pull Boxes:

1. Install pull boxes at every other 90-degree bend.
2. Locate pull boxes at maximum 15 meter intervals along conduit runs.
3. Pull boxes must be accessible to installer using ladder for installation, and inspectable when installed above ceiling grid.

G. Junction Boxes:

1. Junction boxes serving TSS must be metallic and serve TSS only.
2. Junction boxes may be surface mounted above the ceiling where applicable.

H. Electrical Cabinets and Sub-Electrical Cabinets:

1. Main EC Room is located in primary compound building. Sub-EC Rooms are in outlying buildings (e.g., CACs, MSGR+). When untrust network equipment is installed may be designated as LAA.
2. Electrical cabinets or sub-electrical cabinets must serve as central termination for TSS conduits and signal wiring.
3. Install electrical cabinets and sub-electrical cabinets to allow at least 50 mm clearance on sides or ends of cabinets, and between conduit and wall, to facilitate installation of lock-nut and bushing terminations.
4. Main EC Room is interface cabinet tying all TSS terminal equipment into controls in Main EC Room or Post 1.
5. Component Mounting: Components mounted into Main EC Room and Sub-EC Room cabinets must use DS-approved DIN rail connectors to minimize space utilization.
6. Provide separate Active Barrier Sub-EC in CAC building which performs vehicle inspections.
7. Provide separate, dedicated electrical cabinet (EC) for video signals and SVS power wiring.
8. Provide Surge Protection Devices where applicable (e.g. DIN rails).

I. Power Metallic Raceway and Wiring Ducts:

1. Within all EC rooms, use metallic raceways or wiring ducts.

J. Active Vehicle Barrier Controls:

1. For hydraulic vehicle barriers, route conduit from Active Barrier EC at CAC to Post 1 through Main EC Room.
2. Segregate barrier control wiring from all other wiring.

K. Door Control:

1. Terminations: Install short conduit from junction box positioned above door directly into door lintel. Install junction boxes on secure side of door, and above ceiling where applicable. When doors are part of larger glazed assembly, conduits must enter underground directly into door threshold.
2. Route all door control cables from door to Main Electrical Cabinet.
3. Wire doors designated for monitoring only to Main EC Cabinet, and extend to annunciation panels in Post 1 or appropriate Intrusion Detection System (IDS). See Section 281605 "Technical Security Intrusion Detection Systems" for IDS system.

L. Intrusion Detection System (IDS):

1. Terminate unused monitor zones in Main EC Cabinet.
2. Enhanced IDS:

   a. Signal wiring between enhanced IDS input module and end sensor are not permitted to transit unprotected space.
   b. Input Module, Output Module, Alphanumeric Touchpad, Encryption Modules, Automation Modules:

M. Duress Buttons:

1. Terminate unused alarm system zones with resistors in Main EC Cabinet.

N. Security Management Systems Enterprise (SMSe):

1. Connect workstations in Post 1 and Main EC Room by conduit. Connect workstations to TSS Panel "EU" or stand-alone UPS; see Part 3 Article on INSTALLATION – TSS PANELBOARDS.
2. Install conduit with pull cable between Main EC Room and IRM Server Room for future interconnections.

O. Regional Security Office Technical Workstations

1. Provide one dedicated 50 mm (2 inch) EMT pathway from Main EC room with 24 strands of OM3 fiber installed. One end must be terminated near Technical Workstations in wall-mounted fiber patch panel, and the other in wall-mounted fiber patch panel in EC room. This EMT pathway between rooms must remain in LAA areas or must use applicable HCS conduit installation.

2. In EC room, provide pathway equivalent to one 40-mm (1-1/2 inch) EMT to room overhead cable tray from wall mounted patch panel for continuation to SMSe/SVS equipment rack. This pathway may be raceway or may be omitted if patch panel is located in proximity to cable tray.
3. Two 20A EU circuits from EC room, one for each Technical Workstation. Each circuit must provide a 20A locking receptacle, with continuation up to a 20A straight-blade, duplex receptacle behind associated large-format wall display. Technical Workstations must additionally have non-UPS receptacles as required by OBO Electrical Code.
4. Provide two 40-mm (1-1/2 inch) EMT pathway (one pathway for “small” installations based upon input from OBO/PDCS/DE project Electrical Engineer) from Government provided equipment rack location up to large-format display area, terminating in low-voltage box with pass-through brush plate installed 2000 mm (80 inch) AFF. This low-voltage run may be partially in raised floor or may be within raceway, without the need for conduit. Any vertical runs must be in the listed conduit size and embedded within wall.
5. Provide one 40 mm (1-1/2 inch) EMT pathway from IWA equipment rack to each dedicated RSO office, to be located within proximity to planned OpenNet workstation in each office and terminating in a low-voltage box with pass-through brush plate installed. This should branch off or continue (as needed) to wall opposite desk, terminating in a low-voltage box with pass-through brush plate installed 80" AFF. This low-voltage run can be partially in raised floor and/or within raceway, without need for conduit. Any vertical runs should be in the listed conduit size and embedded in wall. (only required for "large" installation).
6. Color-code all conduit related to the RSO Technical Workstations separately from TSS standard blue/yellow.

P. Safe Havens and Safe Areas:

1. Run cabling for equipment on rack in Safe Haven/Area to Main Electrical Cabinet. Unless otherwise indicated, install two 50-mm (2 inch) conduits between EAP rack(s) in the Safe Haven and one 50mm EAP rack in the Safe Area and Main EC Room.
2. Safe Havens and Safe Areas: Install pull box on wall behind EAP rack.

3.4 INSTALLATION – TSS IDENTIFICATION

A. Refer to Division 26 Section on identification for electrical systems for general execution requirements.

B. TSS Installation:

1. Color coding of wiring must be installed in accordance with Chapter 2 of the OBO Electrical Code.
2. Label wiring between TSS termination and Electrical Closet (EC) terminations.
3. Label wiring at both ends and at intermediate points.

3.5 INSTALLATION – TSS PANELBOARDS

A. Refer to Section 262417 “Panelboards” for general execution requirements.

B. Install the separate distribution panelboards identified below for TSS systems. Locate Panel “EU” next to Panel “E”. No other facility system must draw power from these panels.

1. Panel “E”:

a. Panel must be three-phase.
b. Panel must receive power from main distribution panel (MDP), which is on essential generator bus.
c. Panel must supply single-phase power to Panel “EU” through UPS via an UPS bypass switch.
d. Provide circuit breakers with at least 25 percent of active breakers.

2. Panel “EU”:

a. All TSS systems and equipment must receive power from this panel; the exception is that Panel “EU” must not be used as source of power for door closers at security doors where closers are incorporated only to address accessibility requirements (in relation to requirements of OBO Building Code Chapter 11).
b. Panel must be single-phase input and outputs.
c. Place each load component on separate circuit with 20 Amp minimum circuit breaker, and provide spare circuit breakers for at least 25 percent of active breakers. Provide main input circuit breaker on this panel.
d. Power supply must be on independent “EU” panel circuit breaker.

3.6 INSTALLATION – TSS WIRING DEVICES

A. Refer to Section 262725 “Wiring Devices” for general execution requirements.

3.7 INSTALLATION – TSS ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Refer to Division 26 Section on enclosed switches and circuit breakers for general execution requirements.

B. Install TSS subsystems as indicated on TSS drawings.

3.8 INSTALLATION – INFRASTRUCTURE

A. Locate main TSS power equipment, UPS units, and panels in Main EC Room.

B. Equipment Racks:

1. Post 1.

a. Place short racks near deal tray.
b. Place tall racks on side or rear solid walls of Post 1.
c. Clearly label individual modules in each rack.
d. Provide adequate cable length between equipment racks and wall-mounted wire ducts and pull boxes to allow racks to be moved for TSS equipment maintenance access and other facility repairs. This cable length is typically 2 to 4 meters. Secure excess cable length with removable cable ties behind rack.

2. Safe Haven and Safe Area:

a. Equipment rack must receive power from local PCC power.

3. Outlying Buildings: Subpanels and UPS units may be located in Sub-EC Rooms for TSS equipment serving the buildings.

3.9 GROUNDING

A. The Technical Security System must be grounded in conformance with Chapter 2 of the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO) and NFPA 708. Refer to Section 260525 "Grounding and Bonding for Electrical Systems."

B. UPS: As part of a "Separately Derived System" as defined by NFPA 70, neutral conductor of voltage regulator output must be connected to local grounding electrode.

C. Refer to individual specifications on technical security system for additional grounding requirements.

3.10 FIELD QUALITY CONTROL

A. Pretesting: At least one month prior to Accreditation, perform complete pretesting of systems which require field testing to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved.

B. Testing of Cable:

1. Fiber Optic Cable:

a. Test cable plant at 850 nm and 1300 nm.
b. Test fusion splice for insertion loss.

2. CAT 6:

   a. Test in accordance with TIA Category 6 permanent link criteria.

C. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

D. Barcode Labeling: Barcode labels will be government furnished, and made available through the Project Director/COR. The contractor is responsible for:

1. Barcode labeling of TSS equipment costing $500 or more that contains serial numbers, all SVS cameras, SVS network equipment, and TSS equipment costing $1500 or more.
2. Affixing labels prior to installation in a location where they will be readily visible once the equipment is installed.
3. The completion of a Barcode matrix using Word Excel with the following information:

   a. Barcode #
   b. Serial #
   c. Manufacturer
   d. Model/Part #
   e. DS Catalog #
   f. Purchase Date
   g. Install Date
   h. Post Name

4. Provide completed Bar Code matrix to OBO/SM/TSB or Project Director/COR.
5. Removing and destroying labels from damaged uninstall able equipment. Unused barcodes labels should be returned to the Government. Barcodes that are destroyed or damaged barcodes that are rendered unusable do not need to be tracked or returned to the Government.

E. Accreditation: Contractor must perform quality control activities associated with Accreditation.

END OF SECTION 280508

SECTION 281005 – TECHNICAL SECURITY ACCESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Active Vehicle Barrier/gate system controls
2. Door control system

B. Related Sections include the following:

1. Section 087155 “Security Door Hardware” for coordination of door control requirements.
2. Division 26 electrical sections for general electrical requirements, including Section 260525 “Grounding and Bonding for Electrical Systems.”
3. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
4. Section 281805 “Technical Security Access Equipment” for access equipment which do not require detailed assembly design for installation into the Project, such as X-ray machines and explosives detectors.
5. Section 282305 “Security Video System (SVS).”
6. Section 283105 “Technical Security Intrusion Detection System.”
7. Section 284626 “Addressable Fire Alarm Systems” which interfaces with this system as identified in this Section.
8. Section 285115 “Security Management System Enterprise (SMSe).”
9. Applicable Division 32 Section for interface with vehicle barriers.

1.2 SYSTEM DESCRIPTION

A. Active Vehicle Barrier Control System: Facilitate operation of barrier controls at applicable CAC guard booths with active Secondary-control units and Post 1 with Primary override controls. House these controls in TSS equipment racks. Post 1 controls will be rack mounted. CAC guard booths will be desktop mounted.

B. Door Control System:

1. Facilitate remote control and monitoring of security doors from Post 1, local guard post for CACs, and other buildings with PACs.
2. Functions include:

   a. Individual control for all FE/BR doors.
   b. Emergency Lock-Up (ELU) function to secure all doors from a guard station.
   c. Individual door release from ELU function.

d. Interfaces with the Fire Alarm Control Unit (FACU) to unlock the internal security/egress doors.

C. Access Control:

1. CAA Suite Entrance Doors: Remote operation from OMS.

1.3 SUBMITTALS

A. Product Data: Include components, rated capacities, operating characteristics, furnished specialties, dimensions, finishes, and accessories.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

C. Equipment and System Operation Description: Include method of operation. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are not acceptable.

D. Contractor QC Pre-Check Certification: Refer to Section 280508 "Common Work Results for Technical Security Systems (TSS) for combined certification for contractor QC for all TSS sub-systems.

E. Operation and Maintenance Data: Include the following:

1. Operating and maintenance instructions.
2. Data for each type of product, including features and operating sequences, both automatic and manual.
3. Parts inventory list.
4. Purchase source for operating and maintenance materials.

1.4 QUALITY ASSURANCE

A. Perform quality control in advance of QA checks by the Government in accordance with Quality Assurance requirements in Section 280508 "Common Work Results for Technical Security Systems (TSS)."

PART 2 - PRODUCTS

2.1 GENERAL

A. See separate contract attachment, "DS TSS Equipment List" for a listing of products that have been approved for general use in DOS overseas facilities. The selection from this list must be as appropriate for the project.

B. Door Control Systems:

1. Wire accessible pneumatic pump control box using hardware identified in separate contract attachment, "DS TSS Equipment List."
2. Provide door control package suitable for integration with accessible door opener.
3. Provide door control package for all doors assigned a SHW door hardware set containing electrical components, such as a magnetic lock, switch, or electrically released lock. Refer to Section 087155 "Security Door Hardware" for SHW door hardware.

C. Access Control System Accessories:

1. Provide remote release pushbutton.
2. Provide 24-Vdc lock power supply.

PART 3 - EXECUTION

3.1 INSTALLATION – SYSTEM- SPECIFIC

A. See Section 280508 "Common Work Results for Technical Security Systems (TSS)" where use of laptop computer is necessary for programming.

B. Active Vehicle Barrier/Gate System Controls:

1. Coordinate with Section 282305 "Security Video System (SVS)" to facilitate monitoring of barrier functions above with dedicated/fixed camera.
2. Route cabling for controls through dedicated conduit to Post 1 through Main EC Room with no terminations.
3. Provide override control in TSS equipment racks of Post 1.
4. When hydraulic power units are used by barrier system, provide security alarm contact on enclosure door monitored by Intrusion Detection System (IDS). See Section 283105 "Technical Security Intrusion Detection Systems" and applicable Division 32 Section on vehicle barriers.

C. Door Control System:

1. CAC Controls:

    a. Vehicle CAC: Operate from guard booth.
    b. Pedestrian-Only CAC: Operate from guard booth when present.

2. Provide override controls for each individual remote door control module and rack-cutoff for each remote rack at Post 1.
3. Install rack-mounted control modules; for doors penetrating security hard lines at building perimeters; in applicable building. Wire these modules into Main EC Room or sub-EC for applicable building, allowing interconnection and power supply interface with these doors.
4. Refer to Division 08 door hardware specifications for wall-mounted displays and interface devices at fire exits through building hard lines and at some automated access control doors. These doors require wall or header mounted displays and/or interface devices. Security doors in path of egress must unlock via Fire Alarm Control Unit (FACU) upon activation of fire alarm system; provide connection between door control rack and FACU. Modules for fire egress doors must be installed in separate rack than for other doors. Refer to Section 284626 “Addressable Fire Alarm Systems” for FACU and battery.
5. Utilize door control power supplies in Main EC Room or Sub-EC Room associated with each building.

    a. At close or moderate distances from Main EC Room or sub-EC Rooms, normal gauge wiring is usually adequate.
    b. At longer distances from Main EC Room or sub-EC Rooms, higher gauge wire if be necessary, or locate power supply closer to lock.

6. Provide four-hour minimum back-up power for all functions of door control system. Use DS Approved batteries for AES power supplies.
7. Unless noted otherwise, all doors assigned an “SHW” door hardware set in Section 087155 “Security Door Hardware” requires conduit and junction box installed at door header; see Division 26 Section on raceways and boxes.
8. At doors designated for monitoring only, wire to Electrical Cabinet, and extend to low-level alarm annunciation panels in Post 1 or to appropriate Intrusion Detection System (IDS); see Section 283105 “Technical Security Intrusion Detection Systems.”
9. Accessibility Features:

    a. Install accessible power-activation buttons at Public Access Control (PAC) ingress doors to facilitate unassisted access during when PAC lobby is manned by guards. Provide ability to disable this button for after-hours security using disconnect switch in hardened guard booth for PAC area and Post 1. Post 1 will have primary control of the ADA function. When the ADA function is disabled from Post 1 it shall not be able to be turned back on from any other location.
    b. Limit capability to operate power activation of accessible doors exiting PAC to guards in hardened booth.
    c. Provide doors exiting PAC with power activation buttons to facilitate unassisted exiting. Guard in Post 1 or in hardened guard booth serving PAC area must be able to disable this function.

d. Do not install accessible pneumatic pumps further than 15 meters from affected door.
e. Place pneumatic tubing in discrete conduit; pneumatic tubing must not share conduit with electrical and signal cable.

10. Refer to separate contract attachment "Technical Security (TS) Application Guidelines" for the systems identified below for detailed installation instructions and adjustment to manufactured systems.

a. LCN Auto-Equalizer Pneumatic Control System.
b. AES Door Control System.
c. Moniteq CC-8521B Single Door Access Control System.

11. Access Control Accessory Installation at CAA:

a. Install remote release pushbutton at or near OMS desk.
b. Install power supply at OMS desk or above Suite entrance door.

3.2 GROUNDING

A. Conform to Chapter 2 of the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO) and NFPA 780. Refer to Section 260525 "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Inspect field assembly and connection of components, and test operation of controls.

1. Perform these quality control procedures prior to Quality Assurance inspection by the Government.

3.4 DEMONSTRATION

A. Engage service representative to train Government personnel to adjust and operate security equipment. Refer to Division 01 Section "Demonstration and Training." Provide demonstrations for the following systems:

1. Active vehicle barrier/gate system controls.
2. Door control system.

END OF SECTION 281005

SECTION 281805 – TECHNICAL SECURITY ACCESS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. X-Ray Machine
2. Trace detector unit
3. Walk Through Metal Detector (WTMD).

B. Related Sections include the following:

1. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
2. Section 281005 “Technical Security Access Systems” for access subsystems that are assembled as systems, and as such require detailed assembly and coordination design for installation into the Project. These include subsystems such as door controls and vehicle barrier controls.
3. Section 283105 “Technical Security Intrusion Detection Systems.”

1.2 SYSTEM DESCRIPTION

A. X-Ray Machines: Provide package x-ray machines at the following locations:

1. Public Access Control (PAC) areas at each CAC.

B. Trace Detector Unit:

1. Provide units for screening vehicles and pedestrians. Locate in Guard Booths at CACs.

C. WTMD:

1. Provide at Public Access Control (PAC) areas, Service Entrance of the NOB and at personnel screening area of each CAC for screening embassy staff and visitors.

1.3 SUBMITTALS

A. Product Data: Include components, rated capacities, operating characteristics, furnished specialties, dimensions, finishes, and accessories.

B. Contractor QC Pre-Check Certification: Refer to Section 280508 "Common Work Results for Technical Security Systems (TSS) for combined certification for contractor QC for all TSS sub-systems.

C. Operation and Maintenance Data: Include the following:

1. Operating and maintenance instructions.
2. Data for each type of product, including features and operating sequences, both automatic and manual.
3. Parts inventory list.
4. Purchase source for operating and maintenance materials.

1.4 OWNERSHIP OF PROPRIETARY MATERIAL

A. The Government shall retain all rights to software and passwords for software identified in this Section.

B. The Government will sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license must grant use of all programs and application software to the Government as defined by the manufacturer's license agreement, but must protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement must not preclude the use of the software by individuals under contract to the Government for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the owner must be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of the Government.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Requirements for installer qualifications of technical security systems identified in Section 280508 "Common Work Results for Technical Security Systems (TSS)" are not applicable for this section.

1. X-Ray Machines: . All X-Ray machines are required to be installed by a certified technician.

B. Perform quality control in advance of QA checks by the Government in accordance with Quality Assurance requirements in Section 280508 "Common Work Results for Technical Security Systems (TSS)."

1.6 EXTRA MATERIALS

A. Trace Detector Unit:

1. Supply 90 days of consumable support items for this unit. The supply must commence at the project commissioning date.

PART 2 - PRODUCTS

2.1 GENERAL

A. See separate contract attachment, “DS TSS Equipment List” for a listing of products that have been approved for TSS equipment identified in Article on SYSTEM DESCRIPTION. Provide all products for x-ray machine from list unless otherwise noted.

B. X-Ray Machines:

1. Smith Detection HI-SCAN 6040i X-ray Inspection System and 5030i for desktop version.
2. Software: Install the software identified below and provide copy as part of project closeout. Software versions must be as installed at time of system acceptance.

   a. Advanced Package Software: Package includes; Image Store System, X-ACT, Hi-TIP, High Density and OTS Xtrain.
   b. X-plore Software.
   c. Xport Software.

3. Uninterruptable Power Supply (UPS): Provide UPS and UPS Automatic Shut Down Kit both dedicated to X-Ray machine.
4. Roller Table.

C. VOTI XR3D-50s/50/60s/60 X-ray Scanners

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine clearance space and electrical outlets before installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install equipment in accordance with manufacturer's instructions.

B. X-Ray Machines:

1. Refer to separate contract attachment "Technical Security (TS) Application Guidelines" for the systems identified below for detailed installation instructions and adjustments to manufactured systems.

a. Smiths Detection X-Ray Inspection Systems (HI-SCAN 6040i, 6030i, 7555i).
b. Smiths Detection X-ray Inspection Systems 5030i (desktop version).

2. Power source for associated X-ray UPS must be post power from wall outlet.

C. Detection Equipment:

1. Provide back-up power from panel "EU" powered by a TSS UPS; see Part 3 Article on INSTALLATION – TSS PANELBOARDS in Section 280508 "General Work Results for Technical Security Systems (TSS)."

D. WTMD:

1. Place WTMD minimum 500 mm from x-ray machines, doors, or other moving metal construction or equipment.
2. Install dedicated power outlet fed from Panel "EU."
3. Use manufactures calibration/test object tool.

3.3 FIELD TESTING AND ADJUSTING

A. X-Ray Machine: A certified technician must field test and calibrate equipment.

B. Trace Detector Unit: Contractor must perform manufacturer's recommended installation quality control procedures.

C. WTMD: Contractor must perform manufacturer's recommended installation quality control procedures.

3.4 DEMONSTRATION

A. The certified technician used to install equipment shall train Government personnel to adjust, maintain and operate security equipment. Refer to Division 01 Section "Demonstration and Training."

1. X-Ray machine.
2. Trace Detector Unit
3. Walk Through Metal Detector (WTMD).

END OF SECTION 281805

SECTION 282305 – SECURITY VIDEO SYSTEM (SVS)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Security video system (SVS) utilizing Internet Protocol (IP); formerly identified as high-definition video system (HDVS) and closed-circuit television (CCTV) system.

B. Related Sections include the following:

1. Division 26 electrical sections for general electrical requirements.
2. Section 271119 “Communications Termination Blocks and Patch Panels”.
3. Section 271305 “Communications Backbone Cabling.”
4. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
5. Section 283105 “Technical Security Intrusion Detection Systems”.
6. Section 285115 “Security Management System Enterprise (SMSe).”

1.2 SYSTEM DESCRIPTION

A. General: Provide cameras with housings that accept mount conforming to each specific application (e.g., wall, pole, or ceiling). Provide supporting system infrastructure and wiring to cameras. Provide approved configuration and operating system to ensure camera operates correctly on Genetec system.

B. Security Video System (SVS):

1. Systems consists of interoperable hardware, software, networking components, database components, and IP communication protocols.
2. System must facilitate viewing of live and recorded video images and controlling of all network cameras.
3. Network must be implemented with redundancy features; when primary system is impaired, all cameras, network, and server components must automatically switch over to redundant system.
4. Network must be protected by firewall from untrust to trust side of SVS.
5. System must utilize Fiber Optic backbone to support distance greater than 100m and data rates over 1000Mbps. Fiber optic backbone must use either multi-mode 50 um fiber or single mode 9 um fiber, depending on distance runs.

C. SVS System Objectives:

1. Assist guard force by providing real-time visual input, supporting access control and security incident response.
2. Assist security personnel in assessing security events detected through other means (e.g., through alarms, duress buttons).
3. Capture and preserve visual record, for 30 days for lock and leave facilities and 14 days for constant presence oversea posts, of significant acts directed toward Department overseas facilities, and provide forensic evidence to security officers for use in investigations.

D. SVS Coverage: Provide coverage for the following areas:

1. Fixed SVS Cameras: These cameras must view:

a. Compound Perimeter: View compound perimeter in such a way that top and exterior side of perimeter wall or other barrier are visible. Field of view for these cameras must overlap to ensure complete coverage to prevent blind spots. Cameras must not be more than 45 meters (150 feet) apart. Install perimeter SVS equipment in compliance with anti-climb provision.
b. Compound Access Control (CAC) Facilities and Public Access Control (PAC). SVS fixed cameras must view personnel and public queuing areas. These views must include visitor access and screening areas, with overall view of area and of walk-through metal detectors (WTMD).
c. Vehicle gates and vehicle screening areas, including front of approaching vehicle. These views allow marine security guard (MSG) or local guard responsible for supervising vehicle inspection to view both vehicle and screening area, including both entry and exit gates.
d. Provide unobstructed view of active vehicle barriers, and at compound parking structures (including those on compound outside of perimeter compound wall/fence).
e. Receiving docks and delivery areas, including overall view of exterior area and loading or access doors.
f. External side of all exterior hardline doors and roof hatches, including every building on compound.
g. Attack side of fire exit doors.
h. Consular section teller windows (including visa section, American Citizen Services, and other consular waiting areas) with views of public waiting area. Supplemental PTZ surveillance cameras within the consular section may be used to supplement views from fixed cameras.
i. CAA Safe Haven and Safe Area:

1) Cameras shall view entrances and egresses. Install these cameras in inconspicuous manner and mount them at safe and secure distance to view side of door subject to attack. These cameras are not to be tied into main SVS network, and only connect to monitors in their respective areas. These cameras shall only function when the area is in active use. Video for these cameras shall only be recorded at lock and leave facilities. Each camera must

have the ability to have power removed independently from the Safe Haven/ Safe Area. These camera and lens combinations must be capable of recognition;

j. NON CAA Safe Haven and Safe Area:

1) Cameras shall view entrances and ingresses. Install these cameras in inconspicuous manner and mount them at safe and secure distance to view side of door subject to attack. These cameras shall be tied into the main SVS network. These cameras shall be viewable by Post 1 and the Safe Haven\Safe Area. Continuous power for these cameras shall originate in the Security Interface Cabinet (SIC) room and be supplied from the essential uninterruptible (EU) power. Video from these cameras shall be recorded by the Post's SVS system.

k. Public Access Areas:

Multipurpose Room (MPR).
American Center.

l. Interior view of Main EC room that houses SMSe equipment.
m. Gallery/Atrium space.
n. External/attack side of NOB/NOX roof, balcony, and terrace doors,
o. Attack side of interior hardline doors, except for the Interview Room. Exterior of Representational residence (e.g., CMR) located on same compound as Chancery.
p. [Areas required by Lock and Leave (L&L) requirements in accordance with Chapter 4 of the OBO Building Code (International Building Code as amended by OBO.]
q. [Elevator lobbies, when post is in shared building, and when elevator provides access to CAA entrance.]
r. MSGR Emergency Residential Response Room looking at inside of door.

2. PTZ Cameras: These cameras must view:

a. CAC's: Exterior side of entrances and exits to compound and to screening area.
b. Main building entrance to office buildings.
c. Pedestrian areas with high traffic volume.
d. Vehicle movement routes on interior grounds and property.
e. Surface parking at compound site, whether inside or outside of compound perimeter wall/fence.
f. Inside and outside compound perimeter wall/fence, including gate entry and exit points.
g. Compound Parking Structures: Provide at least one camera per ramp.
h. Install at least four PTZ cameras on NOB and NOX rooftop to supplement coverage within compound perimeter wall/fences.

i. Provide PTZ cameras on all building rooftops to aid in compound surveillance. These locations are preferred as infrastructure is within building and not exposed to vandalism.
j. Perimeter Wall: Install at corners and curved areas to supplement views from fixed cameras, removing blind spots in overall coverage.
k. Vehicle Sally Port: Provide coverage of blind spots of interior to supplement views from fixed camera.
l. PACs: Provide cameras to supplement views from fixed cameras.
m. Provide coverage of all walkways and driveways leading from CACs to main office building and consular entrances.
n. Provide coverage of consular public walkway and exterior waiting areas.

3. Video Recorders:

a. Four different sizes of Network Video Recorder (NVR) are included in the "DS Approved TSS Equipment List" (separate contract attachment). Selection must be based on number of cameras that are being recorded. To determine size, identify number of cameras in system design and multiply by 1.15 (to account for future growth); select NVR model that accommodates number calculated.
b. [Lock and Leave Posts: Provide dedicated Digital Video Recorder (DVR) or Network Video Recorder (NVR) in Main EC Room for CAA cameras. Coordinate with intrusion detection for Main EC Room; see Section 281605 "Technical Security Intrusion Detection Systems."]

4. Server/Equipment Racks: Core server and network equipment is located in Main EC Room.
5. Remote Interface Cabinets (RIC) and Interior Interface Cabinets (IIC):

a. Use to connect perimeter cameras to network only when closest sub-EC is further than 90 meters from camera or group of cameras.
b. RIC use should be minimized, and only used when camera placement necessitates.
c. IIC are installed in interior temperature-controlled rooms, and thus can use switches that are not ruggedized.

6. Workstation Type: Type is based on number of camera and monitors in system, as follows:

a. High End Workstation: For up to 32 HD camera streams and eight monitors
b. Medium Workstation: For up to 16 HD camera streams and four monitors
c. LGF Workstation: For up to 8 HD camera streams and two monitors

7. Workstation Distribution and Configuration:

a. Main EC Room: High End Workstation with one rack mounted 475 mm (19 inch) monitor.

b. Post 1: High End Workstation with minimum of two 1050 mm (42 inch) or larger monitors, and two 475 mm (19 inch) or larger monitors. An additional 475 mm (19 inch) or larger monitor will be located in the rack above the vehicle barrier controls.
c. Post 2, if applicable: Four 475 mm (19 inch) monitors.
d. Safe Haven: High End Workstation with rack mounted equipment. One 475 mm (19 inch) monitor.
e. RSO Office: One 475 mm (19 inch) monitor.
f. ESC Office: One 475 mm (19 inch) monitor.
g. Each CAC: Each CAC includes one dedicated LGF workstation located in NOB Main EC Room. Each of these workstations must have minimum one 475 mm (19 inch) monitor, but no more than two 450 mm (19 inch) monitors. Video signal will transmit from workstation to each monitor through video extender.
h. [For Lock and Leave posts, controls required at CAC workstations must use PS2 extender.]

8. Edge Switches: Utilize in remote riser closets, Sub-EC Rooms, Main EC room, and Remote Interface Cabinets (RIC).
9. Cable Installation and Management: Install with patch panels, patch cables, and fiber jumbers in accordance with Telecommunications Industry Association (TIA) standards, including TIA-568, TIA-569-B, and TIA 607-A related to data centers.

1.3 SUBMITTALS

A. General: Submit drawings, diagrams, and equipment schedules through COR to OBO/SM/SCD/TSB for review and clearance.

B. Product Data: Include system components, rated capacities, operating characteristics, furnished specialties, dimensions, finishes, and accessories. Include mounting poles and other accessories.

C. Shop Drawings: Submit detailed block diagram showing components and infrastructure. Indicate components with model numbers.

D. Equipment Schedules: Submit in spreadsheet form indicating the following:

1. Location.
2. Camera: Type and model.
3. Lens: Type and model for fixed cameras.
4. Designation.
5. IP address.
6. Firmware version used in camera model.
7. Archiver designator.
8. Switch port.
9. Power source.
10. Housing model.
11. Mount model.

E. Installer Qualifications: Include applicable industry qualifications and required training certificates.

F. Contractor QC Pre-Check Certification: Refer to Section 280508 "Common Work Results for Technical Security Systems (TSS)" for combined certification for contractor QC for all TSS sub-systems.

G. Operation and Maintenance Data: Include the following for components not from the DS approved list:

1. Operating and maintenance instructions.
2. Data for each type of product, including features and operating sequences, both automatic and manual.
3. Parts inventory list.
4. Purchase source for operating and maintenance materials.

1.4 QUALITY ASSURANCE

A. Perform quality control in advance of QA checks by the Government in accordance with Quality Assurance requirements in Section 280508 "Common Work Results for Technical Security Systems (TSS)".

B. Design and Installation Qualifications: SVS designers and installation technicians who retain applicable industry certifications and factory training in order to purchase products, receive technical support, and support warranty provisions. Contractor personnel involved in the work of the SVS system must receive all applicable training required by each system and vendor.

1.5 PROCUREMENT AND SHIPMENT

A. Procure and ship the following via secure means in accordance with Division 01 Section "Construction Security":

1. Directory server.
2. Network video recorders (NVR).
3. Trusted switches.
4. Firewall.
5. Workstation.

PART 2 - PRODUCTS

2.1 GENERAL

A. Approved Products: See separate contract attachment, "DS Approved TSS Equipment List" for a listing of products that have been approved for use in DOS overseas facilities. The selection from this list must be as appropriate for the project to provide functional system in accordance with the Article on SYSTEM DESCRIPTION.

2.2 SOFTWARE

A. Product configuration for trust side products (including components such as firewalls, server, workstations, and switches). Use DS approved software configurations to facilitate installation programming.

B. Vendor must obtain and furnish product software licenses and firmware for all IP equipment in system.

2.3 NETWORK

A. Provide a redundant SVS Network consisting of, but not limited to, servers, Network Video Recorders (NVR), client workstations, trusted switches, firewalls, and distribution switches.

B. Directory Server

1. Operates Video Management System (VMS) for network configuration and NVRs.

C. Network Video Recorders (NVR):

1. Capable of providing low band width image for remote viewing.
2. Capable of recording each camera at minimum of 1080.

D. Capable of retaining all recorded video for 14 days for constant presence posts, and 30 days for lock and leave posts. Trusted Switches:

1. Connects Directory Servers, viewing clients, NVRs, and Firewalls.
2. Supports redundant power supplies.

E. Firewall:

1. Protects trust side equipment from untrust equipment (e.g., cameras and edge switches). Supports redundant power supplies.

F. Distribution Switches:

1. Connects edge switches or other approved untrust devices to Firewall/Cores.
2. Supports redundant power supplies.

G. Edge Switches (8, 12, and 24 port switches): These switches provide built-in uplink ports, and may provide Power over Ethernet (PoE).

1. Provide secondary power supplies, if available with switch model.
2. Switches located in non-temperature-controlled areas require use of ruggedized type.
3. Utilize Small Form-factor Pluggable (SFP) Modules when required for distances and data rates to distribution switch.
4. For PoE configuration, verify power requirement as PoE I 802.3 at (12.95W) PoE+ is 802.3 at (25.5W)

2.4 REMOTE INTERFACE CABINET (RIC)

A. Remote Interface Cabinet (RIC): Components housed in RIC must include, but are not limited to, the following:

1. NEMA 4 enclosure with insert panel and modified with a hasp, fans and louvers.
2. Ruggedized Edge Switch.
3. Transformers.
4. Circuit breakers.
5. Patch panels.
6. fiber convertors.
7. PoE extender.

B. If RIC is located in sun-exposed location in high temperature environment, provide sun shield to reduce internal RIC temperatures.

2.5 SERVER/EQUIPMENT RACKS

A. Description:

1. Dimensions: 2100 mm (84 inches, 45U) high x 900 mm (24 inches) wide x 600 mm (36 inches) deep.
2. Components: Split mesh doors, casters and leg levelers, and two 250 mm (10 inch) cooling fans

2.6 PC WORKSTATION

A. DS approved products as selected based on parameters identified in the Article on SYSTEM DESCRIPTION and on overall system design.

2.7 ASSOCIATED COMMUNICATIONS COMPONENTS

A. Provide associated communications components to achieve functioning system. Associated components include, but are not limited to, the following:

1. CAT6 and multi-mode fiber optic cable with LC connectors.
2. Fiber optic patch panels.
3. HDVS Patch cables.
4. Fiber jumpers.

2.8 CAMERAS AND CAMERA ACCESSORIES

A. Cameras - General: Digital and IP addressable. Capable of providing low bandwidth second stream for remote viewing.

B. Cameras - Safe Havens and Safe Areas: Standalone digital systems not connected to main SVS system.

C. Cameras must be capable of recording operating with to the approved video management system (VMS). Selected camera model and firmware must on the supported device list for the approved VMS version.

D. Mounting Poles: Provide poles for mounting exterior SVS cameras.

1. Poles for pole-mounted camera must not exceed 4 meter in height.
2. [Utilize hinged wall/standalone poles.]

PART 3 - EXECUTION

3.1 GENERAL

A. See Section 280508 “Common Work Results for Technical Security Systems (TSS)” for use of laptop computer or workstation where that is necessary for programming.

3.2 NETWORK INSTALLATION

A. The Main EC Room will house primary network equipment. All equipment associated with this system must be housed in separate dedicated systems rack in that room.

3.3 WORKSTATION EQUIPMENT INSTALLATION

A. EC Room: Rack mount equipment.

B. Safe Haven and Safe Area: Rack mount equipment.

C. Post 1:

1. Position monitors so that bottom of screens are minimum of 1050 mm (42 inches) and top of screens are maximum of 2100 mm (84 inches) above finished floor.
2. Wall or Column Mounting: Utilize fully articulating and extendable mount for monitors.

3.4 EDGE SWITCH INSTALLATION

A. Install as follows:

1. Wall mount switches at location in RIC enclosure or rack mount switches in rack.
2. Connect Switches to the Distribution Switches via Fiber Optic for distances greater than 90m utilizing two uplinks for redundancy. For distance less than 90 m, use CAT6 to connect edge switch to distribution switch.
3. Connect switches to cameras via CAT6 cables if distance is less than 90m. If distance is greater than 90 m, Ethernet extender is required. Connectors must use TIA/EIA T568B pin assignments.

3.5 REMOTE INTERFACE CABINET (RIC) INSTALLATION

A. Protect RIC with Intrusion Detection System (IDS); see Section 283105 “Technical Security Intrusion Detection System”.

B. Use PoE and extenders; these have been approved for distance over 90 m.

3.6 GENERAL COMMUNICATIONS COMPONENT INSTALLATION

A. Patch Panels: Install for each SVS rack in Main EC Room and Safe Haven workstation to provide cable management and termination points. Patch panels may be used at Power over Ethernet (PoE) switch locations. The rating on the patch panel should meet or exceed the CAT6 cable rating.

B. Fiber Optic Cable:

1. Connections from each switch to other network device must use fiber optic cable when distances exceed 90m and 1 Gps. The fiber optic connectors are attached via fusion splicing and tested for insertion loss.
2. Provide patch panel.
3. To facilitate future fiber expansion, pull at least 30 percent extra with minimum of two extra strands. Terminate every strand of fiber and tested with appropriate LC connector. Install dust/end caps at disconnected or unused strands to prevent dust buildup.

C. CAT 6 Cable:

1. Use for PoE to cameras within same building in which Edge switch is located.
2. Use for PoE to fixed cameras.
3. Use for PoE+ to PTZ cameras when country's 10-year historically lowest recorded temperature doesn't drop below camera's lowest operating temperature.
4. Maximum cable distance from any camera to switch must be 90 meters. Use extenders for distances greater than 90m.

3.7 CAMERAS AND CAMERA ACCESSORIES

A. Install SVS cameras to in manner to facilitate maintenance without use of specialized equipment (e.g., hydraulic lift, scaffolding, extension ladder over 3.7 meters, or free-standing ladder). The system design must consider safety for maintenance personnel. Maximum camera installation height is 8 meters.

B. Cameras and ancillary equipment mounted on stand-alone poles must be accessible from the ground for maintenance. Pole design must consider the safety of maintenance personnel and preclude use of any specialized equipment/ladders.

C. Configure layout to gain most complete useful coverage. Use of "home" position programming is required for PTZ cameras.

D. Cameras for Safe Havens and Safe Areas must be fed directly to EAP rack.

E. Focus each camera and ensure clear daytime and nighttime view. IK10 vandal resistance rating is required for any cameras within 3 meters of the ground.

F. Install swing mounts at perimeter wall/fence and at rooftop parapet locations.

G. Mount cameras on poles as necessary to support viewing and where mounting surfaces are not available.

3.8 ELECTRICAL AND COMMUNICATIONS INFRASTRUCTURE INSTALLATION

A. Exterior cameras power configuration: Provide one of the following configurations as appropriate:

1. Powered by low-voltage circuit from power supply in Main EC Rooms and Sub-EC Rooms.
2. Powered by dedicated circuit supplied from DS-approved transformer (e.g., inside Remote or Interior Interface Cabinet (RIC or IIC)). This transformer must be circuited from dedicated circuit from panel "EU".

3. PoE/PoE+ may be used as long as total power consumption for cameras does not exceed PoE/PoE+ power ratings.

   a. Cameras with heaters and blowers may exceed power ratings of PoE/PoE+.

B. Power SVS equipment by panel "EU"; see Article on INSTALLATION – TSS PANELBOARDS in Section 280508 "General Work Results for Technical Security Systems (TSS)". UPS supplying EU power must provide 15 minutes of run time and be backed up by compound engine generator; see Section 263214 "Engine Generators." If compound generator is not available for backup, use UPS to provide one hour of run time at full load.

C. House step-down transformers supplying cameras in NEMA weatherproof enclosure if required.

D. Safe Haven SVS rack must be powered from rack mounted UPS. Connect this UPS to breaker in PCC panel that is feed from PCC generator.

   1. UPS must supply 15 minutes of run time to equipment.

E. Refer to separate contract attachments "Technical Security (TS) Application Guidelines"; Guidelines with detailed installation instructions and adjustments to manufactured systems may be available for this system.

   1. Deployment Document Genetec Security Center

3.9 GROUNDING

A. Conform to Chapter 2 of the OBO Electrical Code (NFPA 70 "National Electrical Code" as amended by OBO) and NFPA 780.

B. Provide protection for SVS camera poles at the following locations:

   1. Compound perimeter wall-mounted SVS cameras must be installed with copper clad steel grounding conductor and air terminal when mounted to poles or wall.
   2. Building-mounted SVS cameras connected to building roof lighting conductors.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Representative: Engage factory-trained service representative to inspect and adjust field assembly and connection of components, and to start up and commission system.

   1. Perform these quality control procedures prior to Quality Assurance inspection by the Government.

3.11 DEMONSTRATION

A. Engage quality assurance representative to demonstrate proper operation of SVS system, and train post staff on operation and maintenance of system.

END OF SECTION 282305

SECTION 283105 – TECHNICAL SECURITY INTRUSION DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Intrusion Detection System (IDS).

B. Related Sections include the following:

1. Section 083454 "Forced-Entry (FE)/ Ballistic-Resistant (BR) Door Assemblies."
2. Section 087155 "Security Door Hardware."
3. Division 26 electrical sections for general electrical requirements.
4. Section 280508 "Common Work Results for Technical Security Systems (TSS)."
5. **[Section 282305 "Security Video System (SVS)" interface for Lock and Leave installations.]**
6. Section 285115 "Security Management System Enterprise (SMSe)."

1.2 SUBMITTALS

A. Product Data: Include components, rated capacities, operating characteristics, furnished specialties, dimensions, finishes, and accessories.

B. Contractor QC Pre-Check Certification: Refer to Section 280508 "Common Work Results for Technical Security Systems (TSS) for combined certification for contractor QC for all TSS sub-systems.

C. Operation and Maintenance Data: Include the following:

1. Operating and maintenance instructions.
2. Data for each type of product, including features and operating sequences, both automatic and manual.
3. Parts inventory list.
4. Purchase source for operating and maintenance materials.

1.3 QUALITY ASSURANCE

A. Perform quality control in advance of QA checks by the Government in accordance with Quality Assurance requirements in Section 280508 "Common Work Results for Technical Security Systems (TSS)."

PART 2 - PRODUCTS

2.1 GENERAL

A. See separate contract attachment, "DS TSS Equipment List" for a listing of products that have been approved for general use in DOS overseas facilities. The selection from this list must be as appropriate for the project.

2.2 SYSTEM DESCRIPTION

A. Intrusion Detection System (IDS): System includes controllers, power supplies, sensors, processors, switches, and other devices to detect change in environment. The system also includes ancillary equipment to facilitate monitoring and recording data received from system. CLAN devices are required for Standard and Enhanced systems. In accordance with DOS requirements, IDS controller must be limited to a maximum of four partitions for LAA and CAA (restricted) controllers.

1. Standard IDS:

a. See Table 3.4-1, "Standard IDS Devices" at end of this Section for location parameters for standard IDS components included in that table.
b. Protect areas identified in Table 3.4-1, "IDS Devices," with low-level alarms monitored by an annunciation panel in Post 1(i.e., without control unit and keypad).
c. [For Lock-and-Leave buildings provide a control unit and keypad for building perimeter]

2. Enhanced IDS:

a. See Table 3.4-2, "Enhanced IDS Devices" at end of this Section for location parameters for enhanced IDS components included in that table.
b. Controlled Access Area (CAA):

1) Suites/Rooms: Protect every workspace and office within a CAA suite with volumetric motion sensors and door contacts. System is monitored with a keypad and controller and annunciates on an encrypted receiver.
2) CAA circulation: Protect corridor, stairwell, work areas and support spaces not located within suite(s) with volumetric motion sensors and door contracts. System is monitored with a keypad and a controller (located in each CAA floor) and annunciates on an encrypted receiver.

c. Limited Access Area (LAA):

1) LAA Rooms/Suites: Protect with volumetric motion sensors, keypad, and door contacts. System is monitored with keypad and controller and annunciates on an encrypted receiver.
2) Horizontal LAA: Protect with volumetric motion sensors and door contacts. System is monitored with keypad and controller and annunciates on an encrypted receiver.
3) Vertical LAA: Protect with volumetric motion sensors and door/hatch contracts. System is monitored with keypad and controller and annunciates an on encrypted receiver.

d. [For Lock-and–Leave posts, do not provide encrypted receiver. CAA Controller must act as standalone system with printer.]

2.3 SYSTEM COMPONENTS

A. Door Monitor Switches: High-security biased/balanced magnetic contacts. For doors receiving security door hardware, magnetic contacts will be provided with the door; see Section 083454 “FE/BR Doors Assemblies,” and Section 087155 “Security Door Hardware.”

B. Volumetric Motion Sensors.

C. System Power Supply: Supply must include battery-backup.

D. Control Unit.

E. Input Module, Output Module, Encryption Modules, Automation Modules.

F. IDS annunciator.

1. Standard:

a. Monitored by an annunciator panel in Post 1.

2. Enhanced:

a. Operated by a keypad and controller.
b. Monitored by separate encrypted receiver in Post 1.

G. Systems Software: Provide and utilize manufacturer’s standard software developed to facilitate installation programming.

PART 3 - EXECUTION

3.1 INSTALLATION

A. IDS - General:

1. Connect each IDS alarm panel to annunciator panels in Post 1 through Main EC Room.
2. Alarm and tamper circuits for all intrusion detection devices must annunciate independently for all panel classifications (i.e., standard and enhanced).
3. Refer to separate contract attachment "Technical Security (TS) Application Guidelines" for the systems identified below for detailed installation instructions and adjustments for manufactured systems.

   a. Cinch Protector Application Guidelines.

B. Standard IDS:

1. Connect low-level alarms to separate alarm annunciator from one used for enhanced IDS.
2. For doors which require remote locking function from Post 1, install and/or connect door switch at each door to alarm annunciation panel.
3. Provide line supervision between sensor and monitor panel.
4. Monitor TSS power supply AC Fail and Low Battery alarm outputs. Wire as one zone.
5. Volumetric Motion Sensor tamper and alarm must be monitored as two separate zones.
6. Terminate unused monitor zones in Main EC Room with the required resistance.
7. Utilize additional Input Modules with remote modules to create remote input collection hubs from compound outbuildings located in Sub-EC Rooms.

C. Enhanced IDS:

1. General:

   a. Connect enhanced alarm systems to a separate encrypted annunciator panel.
   b. Door switches: Install at all perimeter doors, systems rooms, secure storage rooms and roof hatches.
   c. Monitor tamper detection for all IDS equipment cabinets, or sensors with removable covers. Tamper detection must annunciate at monitoring station and must identify individual component experiencing tampering.
   d. Input Module, Output Module, Encryption Modules, Automation Modules:

      1) Install modules in metal tamper-protected enclosures to accommodate conduit termination and to provide protection.

   e. [Love and Leave Installation: Separate enhanced IDS is required for Lock and Leave facilities.

1) Install associated panel in EC Room; this is the Lock and Leave panel.
2) Panel Partition 1 must be for EC Room. Panel Partition 2 must be for building perimeter doors, motion sensors, and interior hard line perimeter doors.
3) Install keypads on secure side of main EC Room, Lock and Leave primary doors, and Lock and Leave bypass doors.
4) Connect controller module to printer to facilitate monitoring of system events.]

2. CAA Suites:

a. Configure system so that each office suite is discrete system with separate control unit and keypad within space they are protecting.
b. Mount control unit below suspended ceiling. When available, mount unit in discreet location within office suite (e.g., coat closet, storage room); otherwise, mount or near interior side of suite entrance door.
c. Install keypad near interior side of suite entrance door with no direct line of site from the perimeter entry.
d. Volumetric Sensor coverage: Protect suite interior with volumetric motion sensors, including the following:

1) Suite perimeter doors
2) Keypads
3) Every computer workstation; consider distance, angle and height of workstation partitions and file cabinets.
4) Doors: Suite perimeter doors and selective interior doors (e.g., Systems Rooms and Secure Storage Rooms).

3. CAA Circulation and common areas:

a. Door Contacts:

1) CAA entrance/exit to and from GWA, including stairs connecting CAA with General Work Area (GWA).
2) Roof hatches and doors.
3) Conference Rooms.
4) FAX Rooms.
5) TDY/Growth Rooms.
6) Telecom, Electrical, and Mechanical Rooms. (CAA Telecom rooms must be on a separate partition or separate panel.

b. Volumetric Sensor:

1) Entrance and exit doors.
2) Roof doors and hatches.
3) Corridors.
4) CLAN drop/outlet locations.

c. Keypads

1) Keypads for CAA Circulation areas must be surface mounted when on a wall that is shared with LAA or GWA.

4. LAA Spaces:

a. Locate controller in an LAA room or LAA suite. Since controller is limited to four partitions, this same controller can monitor other LAA spaces functionally related, adjacent, and located on the same floor of the building.
b. Mount control unit below suspended ceiling. When available, mount unit in discreet location within room (e.g., coat closet, storage room); otherwise, mount or near interior side of entrance door.
c. Install keypad near interior side of entrance door for each LAA space.
d. Monitor doors with contacts.
e. Monitor keypad and space with a volumetric sensor.

5. Horizontal LAA

a. Provide a separate control unit and keypad located in space or adjacent CAA or LAA.
b. Monitor door contacts.
c. Monitor space with a volumetric sensor.

6. Vertical LAA

a. Provide a separate control unit and keypad in adjacent CAA or LAA.
b. Monitor door and hatch contacts.
c. Monitor space with a volumetric sensor.

7. [Lock and Leave

a. Controllers must act as “standalone” system; it must not report to annunciator.
b. Provide dedicated fixed camera coverage of interior side of CAA entrances and exits.
c. Camera must provide view of keypad when present.
d. Upon valid PIN entry, SVS camera must be disabled.
e. Coordinate dedicated Digital Video Recorder (DVR) or Network Video Recorder (NVR) in Main EC Room for CAA cameras with intrusion detection for Main EC Room.]

D. Partitioning: IDS controllers may be subdivided or partitioned to service different offices of the same agency. Partitioning is permitted subject to all of the following conditions:

1. Each IDS controller is limited to a maximum of 4 partitions for LAA and CAA Restricted.
2. An IDS controller that is partitioned must only monitor spaces that are functionally related, adjacent, and located on the same floor of the building.
3. IDS user interface or sensor wiring must not pass through a floor or ceiling from a monitored space on one floor to a monitored space on another floor. As an exception, vertically aligned riser rooms may be partitioned from a common IDS controller.
4. For each partition, user interfaces (keypads) must be installed inside the monitored space, located near the primary entrance door. Keypads for CAA areas sharing wall with GWA or LAA must be surface mounted.
5. IDS system controller and its partitions must be installed in the same security access area (CAA, and LAA). As an exception, an IDS installed in CAA restricted may be partitioned to include the surrounding LAA buffer; the controller must be installed in CAA.
6. Partitions must stay within a building. Do not extend a partition from one building to another.

3.2 FIELD TESTING AND ADJUSTING

A. Engage manufacturer's service representative to field test and adjust detection systems.

1. Intrusion Detection System (IDS).

a. Verify that motion sensors initiate an alarm condition when a person walks four consecutive steps in any direction at a rate of one step per second.
b. Verify that door sensors produce an alarm before doors they monitor have opened a distance of 25 mm (1 inch); measure this at latch.

3.3 DEMONSTRATION

A. Engage manufacturer's service representative to train Government personnel to adjust and operate security equipment. Refer to Division 01 Section "Demonstration and Training."

1. Intrusion Detection System (IDS).

3.4 SCHEDULES

A. Provide standard IDS devices in accordance with Table 3.4-1, "Standard Intrusion Detection System (IDS) Devices."

B. Provide enhanced IDS devices in accordance with Table 3.4-2, "Enhanced Intrusion Detection System (IDS) Devices."

TABLE 3.4-1
STANDARD INTRUSION DETECTION SYSTEM (IDS) DEVICES

DESCRIPTION/ LOCATION	DOOR SWITCH	MOTION SENSOR W/ TAMPER	TAMPER SWITCH
GENERAL			
* FE/BR Doors (doors in Section 087145) * Not located in CAA or LAA	X		
Sub-EC Room(s)	X	X	
Sub-EC(s)			X
All building perimeter hard-line doors including roof hatches and roll up doors	X		
Vehicle Barrier Electric/Hydraulic Enclosure			X
VOIP Cabinets (located in TRs not in Chancery)			X
NOB			
Mgmt. - FMO Cashier	X	X	
Mgmt. - Pharmacy	X	X	
Consular - Cashier	X	X	
Consular - Visa/Seal Storage	X	X	
Support - Commercial Bank	X	X	
MSGR			
Emergency Response React Room (ERRR)	X	X	

TABLE 3.4-2
ENHANCED INTRUSION DETECTION SYSTEM (IDS) DEVICES

DESCRIPTION/ LOCATION	MSG POST	L&L POST
NOB PERIMETER		
Control Panel		X
Key Pad		X
Door Contact		X
PIR		X
LAA		
Control Panel	X	X
Keypad	X	X
Door Contact	X	X
PIR	X	X
CAA SUITES		
Control Panel	X	X
Keypad	X	X
Door Contact	X	X
PIR	X	X
Fixed Camera		X
CAA CIRCULATION		
Control Panel	X	X
Keypad	X	X
Door Contact	X	X
PIR	X	X
Fixed Camera		X

END OF SECTION 283105

SECTION 283325 – TSS INTERCOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies TSS intercommunication systems for the following types of functions:

1. Facilitate public access control by Marine Security Guards (MSG), and by Local Guards
2. Provide interface between MSG at Post 1 and Guard locations

B. Related Sections:

1. Separate Division 27 Section for non-Consular teller intercoms for MSG and Post personnel interface at teller windows with staff and public at locations other than the Consular Area (e.g., intercom at MSG Post-1 teller window for interface in the Main Lobby), are intercommunications systems that are fully separate from TSS systems in this Section.
2. Section 280508 "Common Work Results for Technical Security Systems (TSS)." regarding for conduits, wire ways, connection boxes, pull boxes, junction boxes, and outlet boxes permanently installed in walls, floors, and ceilings.

1.2 SYSTEMS DESCRIPTION

A. Intercoms to facilitate control of public access:

1. Guard Intercom Device: Audio device located in Guard Booth (Post 1 where applicable) for each applicable building/location.

B. MSG Post 1 intercom interface with Guard Booths, guard desks, and PAC screening areas in other locations:

1. MSG Post 1: Location of main unit for this intercom system.
2. Other locations: Provide all Guard Booths, guard desks, and PAC screening areas with substation tied to main unit in Post 1.
3. Public Intercom Device: Wall-mounted audio device located outside applicable building/compound entrance CAC.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each type of intercommunication system in this Section.

B. Shop Drawings:

1. Wiring diagram of system including power and signal wiring.
2. Wiring diagrams for the interconnection of all components within each system.
3. Power wiring requirements.
4. Jacks and connectors, including types, ratings, locations, and finishes.
5. Racks and enclosures, including physical size, layout, construction, external and internal wiring, ratings, and installation requirements.
6. Operator's and remote panels, including physical size, panel layout, finishing and labeling, ratings, external and internal wiring, and installation requirements.
7. Power amplifiers.
8. Identification, nomenclature, numbering systems, and layout of all nameplates, receptacle plates, and control panels; include physical size, finish, construction, and installation requirements.
9. Room layouts showing location of all equipment.

C. Design Data: Engineering data, diagrams, and acoustic calculations for each system type.

D. Qualifications: Submit evidence of manufacturer’s qualifications in accordance with Article on QUALITY ASSURANCE.

E. Contractor QC Pre-Check Certification: Refer to Section 280508 “Common Work Results for Technical Security Systems (TSS) for combined certification for contractor QC for all TSS sub-systems.

1.4 QUALITY ASSURANCE

A. Perform quality control in advance of QA checks by the Government in accordance with Quality Assurance requirements in Section 280508 “Common Work Results for Technical Security Systems (TSS).”

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide devices and associated power supplies in accordance with Article on SYSTEMS DESCRIPTION, and as identified on Construction Drawings.

B. See separate contract attachment, “DS TSS Equipment List” for a listing of products that have been approved for use on technical security systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. At exterior entrance locations for public access intercoms, ensure smooth mounting surface is prepared on exterior wall for mounting public intercom device. Coordinate location with Project Director/COR.

3.2 INSTALLATION - GENERAL

A. Install systems in accordance with Article on SYSTEMS DESCRIPTION, and as indicated on Construction Drawings.

B. For the following systems, refer to separate contract attachment "Technical Security (TS) Deployment Documents" for detailed installation instructions and adjustments for manufactured systems.

C. Do not run audio cables parallel within 300 mm (one foot) or perpendicular within 150 mm (six inches) of any building ac power, telephone, or other communication system.

D. At connection points for all types of cable, wrap pressure sensitive label strips of the appropriate numbers and letters around each cable near its termination.

E. Take such precautions as are necessary to guard against electromagnetic and electrostatic hum, to maintain the integrity and security of the system, to supply adequate ventilation, and to install the equipment so as to provide maximum safety to the person who operates it.

F. General Component Installation:

1. Install equipment so that components are securely attached to substrate or structure. Connections in public areas must be with tamper resistant or concealed fasteners.
2. Install amplifiers, junction boxes and controller components located at workstations with undercounter mounting, not visible, and installed so as not to interfere with occupant use of space.

G. See Construction Drawings for additional requirements and schematics.

3.3 INSTALLATION – MSG POST 1 AND GUARD BOOTH INTERFACE

A. Route cabling through EC or sub-EC cabinet for respective building.

3.4 FIELD QUALITY CONTROL

A. Inspect field assembly and connection of components, and to test functioning of all installations.

1. Perform these quality control procedures prior to Quality Assurance inspection by the Government.

END OF SECTION 283325

SECTION 283337 – TECHNICAL SECURITY DURESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Duress system.

B. Related Sections include the following:

1. Section 133435 “Mail Screening Facilities.”
2. Division 26 electrical sections for general electrical requirements.
3. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
4. Section 283105 “Technical Security Intrusion Detection System.” This system shares common annunciator in MSG Post 1. Refer to Section for application of IDS Enhanced System.
5. Section 284705 “Mass Notification Systems” for security notification system has no connection with this system.
6. Section 285115 “Security Management System Enterprise (SMSe).”

1.2 SUBMITTALS

A. Product Data: Include components, rated capacities, operating characteristics, furnished specialties, dimensions, finishes, and accessories.

B. Equipment and System Operation Description: Include method and sequence of operation.

C. Contractor QC Pre-Check Certification: Refer to Section 280508 “Common Work Results for Technical Security Systems (TSS) for combined certification for contractor QC for all TSS sub-systems.

D. Operation and Maintenance Data: Include the following:

1. Operating and maintenance instructions.
2. Purchase source for operating and maintenance materials.

1.3 QUALITY ASSURANCE

A. Perform quality control in advance of QA checks by the Government in accordance with Quality Assurance requirements in Section 280508 “Common Work Results for Technical Security Systems (TSS).”

PART 2 - PRODUCTS

2.1 GENERAL

A. See separate contract attachment, "DS TSS Equipment List" for a listing of products that have been approved for general use in DOS overseas facilities.

PART 3 - EXECUTION

3.1 INSTALLATION – SYSTEM- SPECIFIC

A. Duress System:

1. Install buttons in the following locations:

a. Executive: Ambassador (Amb)/ Consular General (CG)/ Principal Officer (PO) Office: connect to IDS Enhanced System when present.
b. Executive: Amb/CG/PO Office Management Suite (OMS) desk; connect to IDS Enhanced System when present.
c. Executive: DCM Office; connect to IDS Enhanced System when present.
d. Executive: DCM OMS desk; connect to IDS Enhanced System when present.
e. Main Lobby screening areas.
f. Main Lobby Interview Room.
g. Main Lobby receptionist booth.
h. Service Entrance guard booth.
i. Service Entrance screening areas.
j. Consular: Screening areas.
k. Consular: Cashier.
l. Consular: Interview Room.
m. Consular: Teller Windows.
n. Support: Commercial Bank.
o. CAC: Screening areas.
p. CAC: Guard booths.
q. MSGR: "Pantry" associated with Recreation Room.
r. Mail rooms receiving local mail.
s. Mail screening facilities, where separate from mail rooms; see Section 133435 "Mail Screening Facilities" where used for project.

2. Monitor buttons at the standard alarm system annunciator panel in Post 1. See Section 280508 "Common Work Results for Technical Security Systems (TSS)."

3.2 FIELD QUALITY CONTROL

A. Inspect field assembly and connection of components and start up and commission system.

1. Perform these quality control procedures prior to Quality Assurance inspection by the Government.

3.3 DEMONSTRATION

A. Engage a service representative to train Government personnel to adjust and operate security equipment. Refer to Division 01 Section "Demonstration and Training."

1. Duress system.

END OF SECTION 283337

SECTION 284626 - ADDRESSABLE FIRE ALARM SYSTEMS

PART 1 - - GENERAL

1.1 SUMMARY

A. This Section specifies an addressable fire alarm system, including requirements for system components typical of those below:

1. Automatic detecting and manual initiating devices
2. Audible and visual notification appliances.
3. Fire Alarm Control Unit (FACU) and all network interfaces for all buildings protected within the compound.
4. Automatic sprinkler water-flow.
5. Supervision of control valves, fire pump controller, auxiliary fire suppression systems (food service hood, pre-action sprinkler system, clean agent suppression system, etc.), water reservoir and temperatures when applicable.
6. Fire safety functions for door release, initiation of smoke control, air handler shutdown and elevator capture and recall.
7. Remote annunciators and controllers.

B. Related Specification Sections: The following Sections contain requirements that relate to this Section:

1. Section 087135 “Non-Security Door Hardware” for applicable sets with door closers/holders, electric doors locks, and release devices that interface with fire alarm systems.
2. Section 087155 “Security Door Hardware” for applicable sets with door closers/holders, electric doors locks, and release devices that interface with fire alarm systems.
3. Section 114000 “Food Service Equipment” for associated hoods.
4. Section 142105 “Electric Traction Elevators” for interlocking of controls with fire alarm and smoke control systems.
5. Section 211305 “Fire Sprinkler Systems.”
6. Section 213115 “Fire Pump Assemblies.”
7. Section 230905 “Instrumentation and Controls for HVAC” on HVAC Controls and Sequence of Operations for fan shutdown and smoke control interface.
8. Division 23 Sections that include duct smoke detector installation requirements.
9. Division 26 Section on raceways and boxes.

1.2 CODES AND STANDARDS

A. Codes: Codes adopted by Overseas Building Operations are identified in Chapter 1 of the OBO Building Code (refer to OBO International Code Supplement (OBO-ICS) to that chapter); refer to contract for applicable version.

B. Standards:

1. American National Standards Institute (ANSI):

a. ANSI/ASME A17.1, Safety Code for Elevators and Escalators.

2. National Society of Professional Engineers (NSPE):

a. National Institute for Certification in Engineering Technologies (NICET), Division of NSPE.

3. National Fire Protection Association (NFPA):

a. NFPA 3, “Standards for Commissioning of Fire Protection and Life Safety Systems,” 2024 edition.
b. NFPA 4, “Standard for Integrated Fire Protection and Life Safety System Testing,” 2024 edition.
c. NFPA 13, “Standard for the Installation of Sprinkler Systems,” 2022 edition.
d. NFPA 14, “Standard for Installation of Standpipe and Hose Systems,” 2022 edition.
e. NFPA 20, “Standard for the Installation of Stationary Pumps for Fire Protections,” 2022 edition.
f. NFPA 25, “Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,” 2023 edition.
g. NFPA 70, “National Electric Code,” as adopted and amended by OBO Electrical Code.
h. NFPA 72, “National Fire Alarm and Signaling Code,” 2022 edition.
i. NFPA 170, Standard for Fire Safety and Emergency Symbols,” 2021 edition.

4. Underwriters Laboratories, Inc. (UL):

a. UL 38, “Standard for Manual Signaling Boxes for Fire Alarm Systems.”
b. UL 268, “Smoke Detectors for Fire Alarm Systems.”
c. UL 268A, “Standard for Smoke Detectors for Duct Application.”
d. UL 521, “Standard for Heat Detectors for Fire Protection Signaling Systems.”
e. UL 864, “Standard for Control Units and Accessories for Fire Alarm Systems.”
f. UL 1971, “Standard for Signaling Devices for the Hearing Impaired.”

C. Conflicts: Where applicable codes and standards differ, notify OBO/OPS/FIRE through the Project Director/COR prior to action. The baseline direction will be to apply the more stringent requirement.

1.3 DEFINITIONS

A. General: Definitions in NFPA 72 "National Fire Alarm and Signaling Code" definitions and in the Codes of Overseas Buildings Operations apply.

B. FAAP: Fire Alarm Annunciator Panel.

C. FACU: Fire Alarm Control Unit

D. Main Primary FACU: Analog addressable fire alarm system is the primary fire alarm control unit in the principal building on a compound. Responsible for protecting the principal building, monitoring all Primary, Remote, Secondary, and Sub-Secondary FACUs throughout the compound, and communicating selected information with Primary FACU to Central Station/Post 1 or where applicable.

E. Global Network Control Annunciator: A full function controllable FAAP.

F. Occupiable Area: Spaces of facility that can be occupied or used by facility occupants as part of building functions or to support building operation and maintenance. This includes, but is not limited to, storage areas, mechanical and electrical equipment areas, restrooms, conference rooms, and individual offices.

G. Post 1: 24-hour manned Marine Security Guard (MSG). Where a Post 1 is not provided on the project, fire alarm equipment normally located in Post 1 must be in a place approved by OBO/OPS/FIRE.

H. Primary FACU: Analog addressable fire alarm system is the primary fire alarm control unit in a building other than the principal building. Responsible for protecting the building, monitoring all Remote, Secondary, and Sub-Secondary FACUs throughout the building in which it is installed, and communicating selected information with Main Primary FACU to Central Station/Post 1 or where applicable via network. Typically, Primary FACU protects an out-building, such as CMR, MSGR, or warehouse where required by the Codes of Overseas Buildings Operations.

I. Qualified Fire Protection Engineer (QFPE) – A Professional Engineer who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Refer to the Part 1 Article on QUALITY ASSURANCE and the Part 3 Article on FIELD QUALITY CONTROL.

J. Regional Security Office (RSO): Under Diplomatic Security (DS).

K. Remote FACU: Remote fire alarm control unit connected to the Main Primary FACU or Primary FACU to allow expansion and distribution of notification, initiation, and signaling line circuits throughout building.

L. Site Security Manager (SSM): Under OBO/CFSM/SM.

M. Secondary FACU: Fire alarm control unit that protects designated area within primary building. Secondary FACU exchanges selected information with Primary FACU.

N. Sub-Secondary FACU: Additional fire alarm control unit used to cover specific areas within area protected by Secondary FACU.

O. System: Where this specification refers to "system", the complete fire alarm system, including all networked or interfaced Main Primary, Primary, Remote, Secondary, and Sub-Secondary FACU systems, is implied.

1.4 SYSTEM DESCRIPTION

A. Intent: Provide complete fire alarm system with alarm initiating devices and notification appliances. System must be complete in all respects, ready for Government operation at project completion.

B. Equipment: Provide equipment as follows:

1. Main Primary FACU: Locate in locked, accessible non-CAA electrical or telephone room.
2. Main Primary Network Control Annunciator: Provide adjacent to the Main Primary FACU.
3. Post 1 Network Control Annunciator: In a panel only sized cabinet inside Post 1. Where possible, battery backup for the network control annunciator should be located outside of Post 1.
4. Post 1 Master Pull Station: Master pull station that overrides maintenance bypass and unlocks all electronically locked doors.
5. Remote FACU: Locate in locked, accessible non-CAA electrical rooms throughout to evenly distribute signaling and notification circuits.
6. Secondary and Sub-Secondary FACU: As required in separate project-specific requirements.
7. Primary FACU: Locate in separate buildings when fire alarm systems are required by Code for those buildings.
8. All control units must have minimum 20 percent spare device capacity.
9. All FACUs must be fully expandable type.
10. Signal Transmission: All initiating devices must be addressable.
11. Detection - Partial: Partial detection via addressable alarm initiating devices must be provided in environments suitable for proper detector operation where indicated below:

    a. Smoke Detectors:

        1) Install in common areas and open areas, corridors, lobbies, telephone and electrical closets, and similar areas.
        2) Do not install in rest rooms, shower rooms, individual offices, kitchens, janitor's closets, or in other areas where prohibited by NFPA 72.

3) Spot-type smoke detectors must not be installed on ceilings exceeding 6.4 m (21 feet) in height; beam or aspiration detection must be used in these areas. Beam detection must have remote test switch at accessible level.
4) Equip smoke detectors in residential spaces, sleeping rooms, and other similar sleeping areas with intelligent sounder base features.

b. Heat Detectors: In fully sprinklered buildings, install heat detectors only in food service areas or where necessary for purposes of elevator shunt trip or other fire and life safety control functions.
c. Exception: Partial detection is not required in fully sprinklered CACs, UTLs, SPXs, PKGs, or RECs that are not associated with residential users.

12. Detection – Life Safety Features: Detection required for life safety features (elevator recall, door hold open, etc.) must be provided as required by NFPA 72 and other codes.
13. Manual fire alarm boxes: Install within 1500 mm (5 ft) on latch side of each exit door and where travel distance between manual fire alarm boxes exceeds 60 m (200 ft). Install one box in Post 1. Do not install boxes in consular waiting or other areas accessible to the general public.
14. Fire Alarm Notification:

a. Audible Notification: Appliances must produce public operating mode minimum sound pressure in accordance with NFPA 72 throughout occupiable areas.
b. Visible Notification: Public mode visible notification appliances must continue to flash when audible notification appliances are de-activated. Install visible notification appliances throughout buildings.
c. Fire alarm notification must be provided by horns and or strobes. General mass notification is not a function of the Fire Alarm System; that is addressed by systems in Section 284705, “Mass Notification Systems.”

15. Facilities Management FAAP: Locate network display-only within BAS Control Room.
16. Elevator Shutdown: Where elevator shafts and/or rooms containing elevator machines or control equipment are sprinkled, elevator power must be shut down by fixed temperature heat detectors in accordance with NFPA 72.
17. Elevator Power Shunt Supervision: Provide where control power supervision is required for elevator power shunt trip.
18. Door Unlocking: Provide addressable interface relay in Post1 within 1 meter (3 ft) of door security control rack.
19. ENS System Monitoring: Provide monitoring of Diplomatic Security Emergency Notification System (ENS) for occurrence of a live or recorded paging event.
20. Fire Pump Monitoring: Monitoring must be in accordance with Section 213115 “Fire Pump Assemblies.”
21. Pump room temperature (if applicable): Provide monitoring of pump room for freezing conditions that could affect driver and water contained within pump and associated piping.
22. Water Temperature Monitoring (if applicable): Temperature supervisory device for water storage container exposed to freezing conditions must initiate two separate and distinctive

signals. One signal must indicate decrease in water temperature to 4 deg. C (40 deg. F) and the other must indicate its restoration to above 4 deg. C (40 deg. F).

23. Water Level Monitoring: Provide in accordance with NFPA 72. High and low water level in fire protection water supply tank, independent of building automation system (BAS) or other electronic monitoring system. Switch must be listed float switch suitable for application. Provide full level annunciation for status only.
24. Fire Safety Functions: Auxiliary fire safety control functions as required by the OBO Building Code in relation to design of each building.
25. Remote Annunciator: Install FAAP within 5 ft on main building entrance except for the building which contains Post 1. Annunciator must have full system control features provided. Display on annunciator must be located between 1500 and 1650 mm (5’-0” and 5’-6”) above finish floor (AFF).
26. Systems Records Document Box:

1.5 SUBMITTALS

A. Shop Drawings. Submit two hard copies and one electronic copy on compact disk of the following information. Submit product data, equipment data, calculations, and the shop drawings simultaneously as one package. Submittal will be deemed incomplete and not reviewed unless it is complaint with the information contained herein, and has attached all drawings, calculations and fire alarm equipment submittal for review.

1. General:

   a. Submittal must include all information required by NFPA 72 Chapter 7, including, but not limited to minimum required documentation, design layout documentation, and shop drawings (installation documentation).
   b. Drawings must be legible, plotted in black and white, and not be smaller than ISO A1 sheets; 600 by 900 mm (24 by 36 inches).
   c. Identify revision number and date. All revisions from previous submittal must be clouded to identify changes to the document.
   d. Identify name of organization, name of system designer, and include stamps or seals by qualified lead designer.
   e. Identify name and address of Post in drawing title block and all transmittals and submitted documents.
   f. Symbols must conform to NFPA 170.
   g. Identify scale use, North direction, and match lines (if applicable).
   h. Include site plan where installation involves multiple buildings.

2. Drawing Content:

   a. Point-to-point wiring of all devices.
   b. Conductor and conduit identity, end of line devices, risers, conduit, conduit fill rate, and junction and pull boxes.
   c. Schedule showing number, type, and size of conductors and conduit planned.

d. Device address or zone and device number for each device.
e. Identification labels, numbers, and references for all conductors and junction boxes.
f. Project-specific details of terminations in floor terminal boxes and all panels.
g. Typical details for mounting and wiring of all device types, terminal and junction boxes, and equipment.
h. Identification of all fire resistance rated walls, and fire stop system to be used in those assemblies.
i. Fire-stopping details for all penetrations through rated construction.
j. Matrix of operation in graphical form. Show all alarm and supervisory input devices on left side, and all possible indications of fire alarm system on top (including bypass functions).
k. Complete riser diagram with all devices.
l. Identify power source and dedicated circuit breaker.

B. Product Data: Submit product data and equipment data for all proposed equipment, devices, wire, conduit, hangers, to be incorporated in the Project. Where multiple items are shown on data sheets, product data sheets must be marked up (circled, highlighted, or strikethrough) to indicate which items will be used/provided and which items will not be. Any item not submitted will not be permitted to be used in fire alarm installation.

C. Manufacturer's Installation Instructions.

D. Calculations:

1. Calculations for all FACUs and NAC power supplies. Battery calculations must include list of all devices connected to FACU or NAC power supply.
2. Voltage drop calculations for all NAC and sounder base circuit.

E. Program configuration: Submit electronic copy on CD-ROM of custom fire alarm system configuration (site-specific software) generated by system's programming software.

F. Certifications:

1. Furnish copy of certifications identified in the Part 1 Article on QUALITY ASSURANCE to OBO/OPS/FIRE through Project Director/COR prior to installation.
2. Training Certificate for Qualified Individual: Furnish a copy of the manufacturer's certificate stating that Qualified Individual (see the Part 1 Article on QUALITY ASSURANCE) has received factory training on the equipment to be installed.
3. Record of Completion: The installing Qualified individual must submit Record of Completion Certification as required by NFPA 72 that the fire alarm system complies with Contract Documents and applicable codes for review by OBO/OPS/FIRE through the Project Director/COR. Submit prior to commissioning.
4. Fire and Life Safety Systems Request for Acceptance Inspection, Testing and Certificate of Occupancy Analysis: Complete portions of document applicable to new fire alarm system for final commissioning. Document must be submitted to OBO/OPS/FIRE through

the Project Director/COR. Refer to the Part 3 Article on OBO/OPS/FIRE PROGRESS INSPECTIONS, COMMISSIONING, AND ACCEPTANCE.

G. Field Tests: Signed copy of Completed Record of Inspection and Test as required by NFPA 72.

1. Report of Pretesting: After pretesting is complete, provide letter certifying installation is complete and fully operable; include names and titles of witnesses to pretests. Documentation must state that all input functions have been tested and that their associated outputs have successfully tested appropriately per the matrix of operations.
2. Report of Tests and Inspections: Provide written record of inspections, tests, and detailed test results, in form of test log. Submit log upon satisfactory completion of tests.

H. Record drawings (As-Builts):

1. Identify and mark wires (wire counts), end of line devices, risers, conduit and conduit sizes, junction, and pull boxes.
2. Label all devices identifying the device address or zone and device number.
3. Label, number, and reference all conductors.
4. Number all junction/splice boxes.
5. Show the location of the riser and the size of the conduit leading into and out of the riser's junction boxes.
6. Operating instructions to be mounted at FACU.

I. Record Operation and Maintenance (O&M) Manuals: Unless otherwise specified, the Contractor must submit to Project Director/COR to be kept at post, completed record Operation and Maintenance Manual: Submit no fewer than two hard copies and one digital bound PDF within thirty days of acceptance. Manuals must contain the following information:

1. Reduced-size: 300 by 450 mm (12 x 18 inches) scaled record drawings, including matrix of operations.
2. Manufacturers' data sheets and installation instructions for all installed equipment and wire.
3. Manufacturer's recommended testing and maintenance schedule and procedures.
4. Complete operating instructions.
5. Repair and troubleshooting guide, which lists common causes for breakdowns, malfunctions, and recommended repairs.
6. List of spare parts provided under this contract.
7. List of replacement parts (with prices) and suppliers where they can be purchased.
8. Battery calculations and voltage drop calculations.
9. Copy of Record of Completion.
10. Copy of Completed Record of Inspection.
11. Manufacturer's certification that fire alarm system complies with Contract Documents and applicable codes.
12. Two electronic copies of bound files on CD/DVD.

a. Provide in version conforming to applicable year OBO BIM and CAD Standards. Where a specific desktop version (e.g., architectural desktop) is used, identify version on CD/DVD.
b. All files must be in DWG files only.
c. All CADD files must be complete and must be audited and purged.
d. All CADD files must be capable of being used without X-reference files.
e. Individual CADD files must contain all information necessary, to include title blocks.
f. OBO border and title block must not be drawn in model space.
g. CADD files must contain layouts for both 600 by 900 mm (24 by 36 inches), and 280 by 432 mm (11 by 17 inches) size in paper space layouts.
h. Electronic data base of manufacturer's fire alarm program.

13. Laminated operating instructions for mounting at FACU.
14. Two copies of NFPA 72 (National Electrical Code); edition applicable to contract.

1.6 QUALITY ASSURANCE

A. Lead Designer: Designer responsible for shop drawings must be certified by National Institute for Certification in Engineering Technologies (NICET) at minimum NICET III level in Fire Alarm Systems or QFPE. Shop drawings must be signed and sealed by this qualified lead designer.

B. Lead Installer: The lead on-site fire alarm system installer must be certified at minimum NICET III level, QFPE or other OBO/OPS/FIRE approved certification and must have minimum of five years hands-on experience in the requirements and installation of fire alarm systems for the different building types included in this project. This individual may or may not be the same person as the qualified individual.

1. On-Site Presence: The Lead Installer must be on site from the beginning of fire alarm system installation through completion, commissioning, and acceptance.

C. Qualified Individual: Employ at least one person with current certified qualifications of at a minimum NICET III level or QFPE. This person must also be certified as having received factory training for Manufacturer's system being installed. This person is designated as the qualified individual.

1. Required Consultation: The qualified individual must meet and consult with OBO site management, OBO/OPS/FIRE/FPE, and lead fire alarm system installer to establish means and methods to install the fire alarm system. This meeting must be held prior to the installation of the fire alarm system. Depending upon project schedule, OBO/OPS/FIRE/FPE may attend meeting via conference call.
2. This individual must furnish to OBO/OPS/FIRE thru the Project Director/COR a monthly report detailing status of the job. Separate reports must be prepared for each building, and each floor of those buildings. This report must include resolution of punch list items, if

applicable, whether generated by contractor or OBO personnel. Also furnish any NFPA certificates of completion for completed systems or sub systems generated since the last reporting cycle.

D. Other Required Personnel: Employee at least one person with current certification of at least NICET II level or higher to assist with pre-testing, final acceptance, and commissioning. This individual must be on site for pre-test and for duration of final acceptance and commissioning. This individual is permitted to be the same person as the qualified individual but cannot be the same person as the lead installer.

E. System Continuity: A single lead designer and a single lead installer must be used for all aspects of the design and installation, including classified work and unclassified work.

F. Manufacturer's equipment, design, shop drawings and equipment submittals are required to be sourced from the United States. In addition, all fire alarm control units must be manufactured in the United States and listed to requirements of UL 864; this includes Main Primary FACU, Primary FACU, Secondary FACU, Sub-Secondary FACU, and Remote FACU. Local sourcing is not permitted without the specific authorization in writing from OBO/OPS/FIRE through the Project Director/COR.

G. Installation must be supervised by manufacturer's qualified individual.

H. Manufacturer or authorized fire alarm subcontractor must provide all fire alarm equipment and programming.

I. Performance Testing, Commissioning and Acceptance: The qualified individual must be present to ensure system compliance with contract documents, resolve discrepancies and conduct system testing before arrival of the OBO/OPS/FIRE representative. The qualified individual must remain on site for the performance testing and acceptance of the system, and to resolve with Project Director/COR any discrepancies found by the OBO/OPS/FIRE.

J. Manufacturer's Field Representation: Provide services of Manufacturer's factory-authorized service representative to supervise field assembly and connection of components, pretesting, testing, and adjustment of system.

K. Approved by OBO/OPS/FIRE: A request via RFI for specific approval to satisfy a requirement within this Section for 'approval by OBO/OPS/FIRE;' for design features the request must be submitted by the Lead Designer. Design feature(s) that are specifically identified as requiring approval by OBO/OPS/FIRE require the specific use of an RFI; the inclusion of design features on design drawings or shop drawings (without the RFI) does not meet the requirement for 'approval by OBO/OPS/FIRE,' even if those drawings are reviewed and accepted/approved by OBO/OPS/FIRE.

1.7 EXTRA MATERIALS

A. General: The contractor must provide, at or before acceptance, extra materials identified below that match products installed, packaged with protective covering for storage, and identified with labels clearly describing contents. The materials must be inventoried with an itemized list given to the Project Director/COR and must provide all critical parts for the system to ensure that a single mode failure can be corrected by using critical parts from the spare parts inventory. The Contractor must provide the minimum specified quantity, but no less than one of each type as follows:

1. Manual fire alarm boxes: 15 percent of number of manual fire alarm boxes installed, minimum of two. Provide five manual fire alarm box keys on the bottom of the Main FACU as spares.
2. LED-type remote indicating units: 15 percent of number of units installed.
3. Spot-type Smoke Detectors, Duct Smoke Detectors, and Heat Detectors: 15 percent of number of units of each type installed, but no fewer than two of each type.
4. Detector Bases: 15 percent of number of units of each type installed, but no fewer than two of each type installed.
5. Projected Beam Smoke Detector: One of each type installed.
6. Notification Appliances: 15 percent of number of units installed, but no fewer than two of each type installed.
7. One complete set of fiber optic isolation equipment and sub-secondary controls, where used.
8. Interface (Monitor and Control) Modules: 15 percent of number installed, but not less than two.
9. Initiating Device Circuit Card: One for each unit installed.
10. Notification Appliance Circuit Card: One for each unit installed.
11. Signaling Line Circuit Card: One for each unit installed.
12. Card Cage or Card Chassis (where they contain electronics): One for each unit installed.
13. Fiber Optic Interface Cards: One for each unit installed.
14. Network Communications Interface Cards/Network Power Supply Cards: One for each unit installed.
15. Fire Alarm System Controls Power Supply: One of each type installed.
16. Main Primary and Main System Processor Board: One of each type installed.
17. Main Primary and Main system expander board.
18. Secondary and Sub-Secondary system processor board. One of each type installed.
19. Fire Alarm Annunciator Panel: One for each type installed.
20. Printer interface module: One of each unit installed.
21. Remote NAC booster panel: One of each type of unit installed.
22. Multi-Criteria tester pole and necessary replacement cartridges (one case of at least six cartridges), and primary and spare batteries.

B. Secure Storage: A minimum of 15% of each type of equipment installed in secure areas, but no less than one, must be provided for secure storage.

C. Unless otherwise specified, any surplus materials, fixtures, articles or equipment remaining at completion of the Project shall remain the property of the Government, except those items furnished by Contractor, cost of which is not included in contract price.

1.8 WARRANTY

A. Contractor's Warranty: Submit a written warranty agreeing to repair or replace any portion of the automatic sprinkler system that fails in materials or workmanship within a period of one year after the latter of substantial completion or final acceptance testing of the fire alarm system, which is witnessed by OBO/OPS/FIRE.

PART 2 - PRODUCTS

2.1 MAIN PRIMARY FIRE ALARM CONTROL UNIT

A. The main primary fire alarm systems controls must:

1. Be analog addressable and network capable.
2. Be capable of optical fiber network communications.
3. Be provided with a minimum 80-character screen or LCD.
4. Not incorporate integral radio transmitters.
5. Incorporate programmable function means, such as a momentary key operated switch or keypad.
6. Have capability to be placed in maintenance bypass mode temporarily so that NAC circuits are not energized upon input of specific device address or zone. Maintenance bypass must require a key or password to be activated and must restore to normal mode automatically after 4 hours if not returned to normal mode manually. Upon de-activation of notification appliances, any existing alarm must be transferred to a visual indicator on main FACU and FAAP. Any subsequent alarms from other zones must cause the alarm notification appliances to re-activate.
7. Be capable of supporting a system printer.
8. Receive and indicate common trouble and supervisory (if applicable) from remote power supplies (NAC extenders), secondary control units, and any other interconnected control units, including suppression system controls.
9. Include USB port(s) for system upload / download.
10. Capability to program entire network from single node.

B. System power supplies:

1. Primary Power Supply:

a. Obtain primary power for FACU from a dedicated emergency power circuit and terminated in accordance with Article 760 of NFPA 70 (model National Electrical Code).
b. Supply must be accessible only to authorized personnel. Identify supply as "FIRE ALARM CIRCUIT" using label or phenolic plate; either must be red.
c. Provide surge protective devices at power input to each cabinet.
d. FACU must have integrated transformer to function with the post or local utilities' voltage and frequency.

2. Secondary Power Supply: UL listed storage battery:

a. Provide sealed valve regulated lead acid (VRLA) batteries as secondary power supply.
b. Secondary power supply must supply energy to system with sufficient capacity of 24 hours under maximum quiescent load and at end of that period must be capable of operating all alarm notification appliances used for evacuation for five minutes.
c. Batteries must be sized at 130 percent of calculated size to compensate for alarm reserve and aging.
d. Provide automatic battery-charging circuitry for each standby battery bank in system. All system battery charge rates and terminal voltages must be readable using fire alarm control unit LCD display in service mode, indicating directly in volts and amperes.

C. All battery boxes must be produced by the same manufacturer as the FACU and must be UL listed for fire alarm service.

D. System Programming Software: Provide latest software revision. Programming must be Microsoft Windows based using latest software version. Use of Virtual PC add-ons is not permitted. Configure system with most current version or revision. Proprietary software must be licensed to OBO/OPS/FIRE for life of system at no additional charge (no annual fee from manufacturer).

E. System Compatibility: New fire alarm installation and program must be compatible with existing fire alarm network. Upgrades to existing software, firmware, or programming throughout the compound must be performed by the Contractor where necessary.

1. Exception: Where existing fire alarm system is a legacy system no longer supported by the manufacturer, and scope of the Project is not a compound fire alarm replacement project, a different manufacturer or system is permitted to be installed where approved by OBO/OPS/FIRE. This new system must be provided with a network control annunciator installed in Post 1 via fiber.

F. Site-Specific Software (database): Provide two copies of the final and accepted configuration (site-specific software, using nonvolatile memory) for OBO/OPS/FIRE use upon system acceptance. One copy must be left inside the control unit, and the second copy must be provided to OBO/OPS/FIRE through the Project Director/COR at time of Commissioning.

2.2 SYSTEM DEVICES

A. Initiating Devices:

1. Signal Transmission: By copper wire or fiber optic only. Aluminum conductors are not permitted.
2. Smoke Detectors: Addressable multi-criteria smoke detectors that can be programmed to use a combination of smoke, heat, and time for specific applications.
3. Heat Detectors: Must be selected to operate at a temperature no less than 11 deg C (20 deg F) above the maximum expected ambient temperature.
4. Bases, Smoke and Heat Detectors: Must be programmable only through the use of switches on the base or detector. Separate handheld or stationary programming units must not be used.
5. Duct Smoke Detectors: Addressable type with a plug-in type detector head, duct mounted housing, and sampling tubes that provide airflow through the duct housing.

    a. All duct type smoke detectors must be provided with keyed remote test switch and indicator light installed in readily accessible location (as defined by NFPA 72).

6. Projected Beam Detectors: Must be of the addressable type, must have remote test feature, and must be provided with remote key test switch in accessible location.
7. Manual fire alarm boxes: Must be of the addressable type and must conform to accessibility requirements of the Architectural Barriers Act (ABA) in accordance with Chapter 11 of the OBO Building Code and must be red in color. Break glass type manual fire alarm boxes shall not be permitted. All manual fire alarm boxes must be single action type.
8. Sprinkler supervisory and alarm initiating devices must be connected to the fire alarm system using addressable interface modules.

B. Notification Appliances:

1. Visible Notification Appliances: UL 1971 compliant and synchronized as required by NFPA 72.

    a. All visible notification appliances must be multi-candela, white in color, and labeled “FIRE” with red letters.

2. Audible Notification Appliances: Electronic horns, sounder-bases or speakers complying with UL 464. Audible notification appliances located in sleeping rooms must produce fundamental frequency of 520 Hz +/- 10 percent, with square wave or its equivalent.

    a. All audible notification appliances must be white in color and labeled “FIRE” with red letters.

C. Global Network Control Annunciator:

1. Dedicated network node utilized as a full function controllable FAAP. Console must have minimum 40-characters per event and display multiple panel or network events simultaneously. Annunciator must be capable of all programmed functions including acknowledge, signal silence, and reset across select fire alarm control units.

D. Fire Alarm Annunciator Panel:

1. Panel must have minimum 40-characters per event, must be capable of acknowledge, silence, and reset functions.

E. Interface Modules: Provide addressable modules that must be programmable only through the use of switches on module. Separate handheld or stationary programming units must not be used. All input/output interface modules must be suitably rated for voltage and current they monitor or control.

2.3 WIRING

A. Low Voltage System Wiring: As required by Article 760 of NFPA 70.

1. Wire must be data grade low capacitance sized for initiating device circuits, with signaling line circuits no less than 1 mm (18 AWG) and not larger than 1.5 mm (16 AWG) as required by manufacturer.
2. Minimum size for notification appliance circuits is 2.5 mm (14 AWG), maximum 4 mm (12 AWG).
3. Wire must be solid unless otherwise required by the manufacturer.
4. Provide surge suppression for all circuits where exiting and entering any structure, connected prior to any system devices within the structure.
5. Conductors and cables for initiating device circuits, signaling line circuits, and notification appliance circuits that are not run underground must be approved/listed for such use, and must be listed for environmental conditions in which they are installed.
6. Conductors and cables for initiating device circuits, signaling line circuits, and notification appliance circuits that are run underground must be approved/listed for such use, and must be listed for environmental conditions in which they are installed.
7. All circuits must provide a minimum of 20 percent spare capacity based on design voltage drop calculation.

B. Power Wiring:

1. Cable for 120/240 VAC circuits must be solid 4 mm (12 AWG) minimum.
2. Primary conductor must be Black, neutral conductor must be White, and ground conductor must be Green.

C. Network Communication:

1. Internal network circuits within buildings must be fiber optic.

2. Internal network circuits must be Class X.
3. External network circuits between buildings must be fiber optic.
4. External network circuits must be Class X.
5. All underground conductors must be approved for such use.

D. Circuitry:

1. Signaling Line Circuits (SLC): Class A.
2. Notification Appliance Circuits (NAC): Class A.
3. Initiating Device Circuits: (IDC): Class A.

E. Circuit Isolation:

1. Provide isolation modules for up to 20 percent of the UL listed max number of devices, but no more than every 20 devices.
2. Provide isolation modules for all circuits entering and leaving a building.

F. Pathway Survivability

1. All fire alarm wiring must have Pathway Survivability Level 1 or Level 2.
2. Interconnection of panels, panels to FATC, circuits between floors, and other risers within NOBs, EOBs, NOXs, SDAs, MSGRs, and similar use buildings must have Pathway Survivability Level 2 at a minimum.
3. High Rise Buildings: Interconnection of panels, panels to FATC, circuits between floors, and other risers within all high-rise buildings, regardless of use, must have minimum Level 2 Pathway Survivability.

2.4 FIBER OPTIC CABLES

A. Multimode Fiber: Fiber optic cable installed as part of fire alarm system must meet or exceed the following specifications:

1. Cable must be 50 micron, enhanced grade, multimode, and graded glass fiber. All materials in the cable must be dielectric.
2. Cable must meet or exceed the performance requirements of fire alarm manufacturer's specifications.
3. Cable must be minimum 6 strand fiber count.
4. Cable must be strait tip (ST). Jumper must be used where required to switch between ST and SC connectors.
5. Plenum Cable (Inside Cable) must be used for all interior installations. Installed cable must meet or exceed the following:

   a. EIA/TIA -598 color coding for fiber optic cable.
   b. Capable of bend radii as small as 20 x outside cable diameter.

6. Outside Plant Cable must be used for all applications where cable is to be run in underground conduits. Outside plant cable may not be used for interior applications and must meet or exceed the following:

   a. EIA/TIA -598 color coding for fiber optic cable.
   b. Capable of bend radii as small as 20 x outside cable diameter.

7. Indoor/Outdoor Cable must be designed to withstand both the rigorous environment of the outdoor as well as conform to flame rating requirements for indoors.

   a. EIA/TIA -598 color coding for fiber optic cable.
   b. Capable of bend radii as small as 20 x outside cable diameter.

2.5 REMOTE FACU

A. Remote unit must be compatible with main system controls and must be produced by same manufacture as Main Primary FACU system and Primary FACU. Remote FACU system controls and Primary FACU system controls must be networked using optical fiber cable. Detectors and notification appliances must be consistent throughout system.

2.6 SECONDARY SYSTEM

A. Secondary FACU: Secondary fire alarm system controls must be compatible with Main Primary FACU and Primary FACU system controls and must be produced by same manufacturer as Primary FACU system. Secondary FACU system controls and Primary FACU system controls must be networked using optical fiber cable. Detectors and notification appliances must be consistent throughout system.

2.7 SUB-SECONDARY SYSTEM

A. Sub-Secondary FACU: Sub-Secondary fire alarm system controls must be compatible with Primary FACU and Secondary FACU system controls; and must be produced by same manufacturer as Primary FACU. Sub-Secondary FACU system controls and Secondary FACU system controls must be networked using optical fiber cable. Detectors and notification appliances must be consistent throughout system.

B. Notification Appliances: Sub-Secondary FACU must be electronic chimes and strobes, unless otherwise directed by OBO/OPS/FIRE through the Project Director/COR.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system in compliance with required and advisory provisions of NFPA 72 and other applicable codes referenced in the Part 1 Article on CODES AND STANDARDS.

B. Fire Alarm Power Supply Disconnect:

1. AC power supplies for all fire alarm controls, notification appliance power extender panels, and other fire alarm equipment must be on a dedicated branch circuit and must comply with NFPA 72 and other requirements of this Section. Provide surge protective devices for each power supply.
2. Label circuit disconnecting means at panel board as "FIRE ALARM" using red label or lettering. Provide with lockable handle or lockable panel board cover. Identify location of disconnect on placard mounted on FACU cabinet door.

C. Keys:

1. All keyed locks must be keyed the same.

3.2 SYSTEM FUNCTIONAL DESCRIPTION

A. General alarm: Provide system general alarm, responding as follows:

1. Indicate general alarm condition at FACU and remote annunciators.
2. Identify device and provide alphanumeric location of the source of the alarm at FACU and remote annunciators.
3. Initiate audible and visible alarm signals throughout building.
4. Close fire and smoke doors that are held open by magnetic door holders.
5. Initiate control functions associated with the activated device.

B. Manual fire alarm boxes: Initiate a general alarm.

C. Smoke detectors: All area smoke detectors must:

1. Initiate a general alarm.
2. Unlock security doors in accordance with “Security Door Control – Door Unlocking” section below within this Article on SYSTEM FUNCTIONAL DESCRIPTION.
3. Signal smoke control panel to initiate smoke control (design dependent fan shutdown and/or damper positioning), door closure/release and other fire safety functions as required.

D. Smoke Detectors at MSGRs and Other Dormitory-Type Facilities without Cooking Equipment:

1. Any one smoke detector within a room/suite must activate all sounder bases within that suite and must register as an ALARM on the FACU. General Alarm will not be activated.
2. Any second detector must activate general alarm to include all sounder bases.
3. Any single hallway or common-area detector must activate general alarm to include all sounder bases.

E. Smoke Detectors as SDA and Other Multi-Unit Living Facilities with Cooking Equipment:

1. Any one smoke detector within a room/suite must activate all sounder bases within that suite and must register as an ALARM on the FACU. General Alarm will not be activated.
2. Any second detector within the same suite must activate general alarm to include all sounder bases.
3. Any single hallway or common-area detector must activate general alarm to include all sounder bases.

F. Duct smoke detectors: Duct type smoke detectors must:

1. Initiate supervisory signal.
2. Shut down associated HVAC fan(s) and initiate smoke control (if provided), in accordance with mechanical design.
3. Duct type smoke detectors must not be used to release any security doors.

G. Elevator smoke detection: In addition to regular smoke detector function, elevator lobby, hoistway (if required), and machine room detectors must:

1. Activate primary or secondary elevator capture and recall.
2. Signal smoke control panel to initiate smoke control (design dependent fan shutdown and/or damper positioning), door closure/release and other fire safety functions as required.
3. Where “Fireman’s Override” switches are installed, actuation of hoistway or elevator machine room detectors must cause a separate and distinct visible annunciation to alert emergency personnel capable of operating “Fireman Override” that elevators are no longer safe to use.

H. Elevator heat detection:

1. Activate power shunt trip to elevator controllers upon or prior to activation of sprinkler heads in hoistway or elevator machine room to avoid wetting down of live electrical components.
2. Indicate alarm signal upon activation.

I. Elevator Shutdown Control Circuit Supervision: Control circuits to shut down elevator power must be monitored for presence of operating voltage in accordance with NFPA 72.

1. Initiate trouble signal.

J. Secondary System Alarm:

1. Initiate alarm on Secondary FACU.
2. Initiate alarm on Main Primary, Primary, and/or Remote FACUs.
3. Initiate alarm on Sub-Secondary FACU.

K. Sub-Secondary System Alarm:

1. Initiate alarm on Secondary FACU.
2. Initiate alarm on Main Primary, Primary, and/or Remote FACUs.
3. Initiate alarm on Sub-Secondary FACU.

L. Sprinkler Water Flow Switch:

1. Initiate general alarm.
2. Unlock security doors in accordance with "Security Door Control – Door Unlocking" section below within this Article on SYSTEMS FUNCTION DESCRIPTION.

M. Supervisory Devices: Initiate supervisory signal upon actuation of on the following items.

1. Sprinkler valve supervisory switches.
2. Fire pump supervisory devices.
3. Water supply supervisory devices.
4. Duct smoke detectors.
5. Remote FACUs, Primary-FACUs, Secondary FACUs, and Sub-Secondary FACU systems.
6. Other supervisory devices.

N. Auxiliary Fire Suppression Systems: Upon activation, initiate alarm.

O. Security Door Control and Door Unlocking: Addressable interface relay provided in Post 1 within 1 meter (3 ft) of door security control rack that unlocks all electronically locked doors. Program to operate upon activation of Post 1 Master Pull Station any two smoke detectors in non-publicly accessible areas, any heat detector in non-publicly accessible area, or activation of sprinkler water flow switch or sprinkler pressure switch. Door release activation must create trouble condition, and display message on FACU and system-logging printer upon fire alarm door release.

P. Alarm Silence During Mass Notification Paging: Provide addressable interface module in Post 1 within 1 meter (3 ft) of SelecTone system. System must be programed that when SelecTone system is transmitting a live page or pre-recorded message, fire alarm system must have its audible notification appliances temporarily silenced while visible appliances remain active. Once live page or pre-recorded message has stopped, fire alarm audible notification appliances must reactivate.

Q. Network Communications: All communications between fire alarm system units must be by Class X fiber network communications. Fiber must be single run continuous from building to building (patch panel to patch panel) without splices.

R. Sounder Bases: Provide intelligent sounder bases and replace any existing conventional sounder bases. Conventional sounder bases must not be permitted in new systems or systems with intelligent sounder bases.

S. Notification Appliances:

1. Audible notification appliances must be silenceable using “Alarm Silence” function.
2. Visible notification appliances must remain activated after audible silence until control unit reset.

T. Maintenance By-Pass Key Switch: Provide momentary key switch on Main Primary FACU (unless otherwise directed by OBO/OPS/FIRE through the Project Director/COR) to enable system testing and maintenance functions. The system must be configured and programmed to provide the following:

1. System Response: Upon activation of Maintenance By-Pass function:

a. Trouble signal must be initiated on system.
b. Display message saying, "System in Maintenance By-Pass".
c. Disable all notification circuits (NAC) throughout building network.
d. Disable all auxiliary fire and life safety control features, including but not limited to elevator recall, AHU shutdown, smoke damper closure, and stair pressurization,

2. Duration: Maintenance By-Pass feature must be configured and programmed for the following duration settings:

a. Disabling of notification and control features must automatically end, without human intervention, after 4 hours.
b. System network must reset in system normal after 4 hours.
c. Full function of the system throughout the building network must be restored upon system reset.

3. Override: Maintenance By-Pass feature must be overridden by manual alarm box installed in Post 1, or in main Post Access Control (PAC) for Lock and Leave posts.
4. Labeling: Key switch must be permanently labeled as to function, by engraved placard or custom engraving of face plate, on interior of panel as follows:

a. Above the key cylinder: "MAINTENANCE BY-PASS SWITCH".
b. Key Positions:

1) At resting place or orientation of cylinder in normal condition include: "NORMAL".
2) At farthest point in arc of key swing include: "DISABLE".

c. Below key cylinder: "OPERATION OF THE SWITCH WILL BYPASS HORNS, STROBES, ELEVATOR RECALL, AND AHU SHUTDOWN FOR UP TO 4 HOURS. TO CLEAR, PRESS SYSTEM RESET SWITCH."

3.3 FACU OPERATION SEQUENCE/INTERFACES

A. Main Primary FACU Alarm:

1. Main Primary FACU initiates alarm condition on Remote, Secondary, and Sub-Secondary FACUs located in the compound principal building by network communication.
2. Remote, Secondary, and Sub-Secondary FACU notification appliances activate throughout the building.
3. Main Primary FACU must control all alarm silencing and reset functions.
4. Network Control Annunciator in Post 1 must control all alarm silencing and resent functions.

   a. Resetting of fire alarm must not require resetting of Remote, Secondary, and Sub-Secondary FACUs.

B. Primary FACU:

1. In a non-principal building, Primary FACU initiates alarm condition on Remote, Secondary, and Sub-Secondary FACUs located throughout the building by network communication.
2. Notification appliances are only activated throughout the building with Primary FACU.
3. Alarm, trouble, and supervisory conditions with intelligent device information are annunciated at Post 1.
4. Acknowledging at the Network Control Annunciator within Post 1 only silences audible alarm at Post 1.
5. Acknowledge, silence, and reset functions must be performed at Primary FACU or remote annunciator for Primary FACU.

C. Remote, Secondary, and Sub-Secondary FACU Alarm:

1. All intelligent device information must be annunciated at Main Primary or Primary FACU and annunciator panel.

   a. General alarm is annunciated on Network Control Annunciator located at Post 1.

2. Activate all notification appliances throughout the building.
3. Primary FACU must control all alarm silencing and reset functions in non-principal building.
4. Main Primary FACU must control all alarm silence and resent functions in the principal building.

5. Resetting of fire alarm must not require resetting of remote, secondary, and sub-secondary FACUs.

D. Maintenance Bypass: Configure four-hour maintenance bypass throughout the principal building only.

3.4 EQUIPMENT INSTALLATION

A. Manual fire alarm boxes:

1. Identify address or device number on exterior of assembly.

B. Water-Flow Detectors and Valve Supervisory Switches:

1. Properly identified at Main Primary FACU indicating location of devices or area covered.
2. Must have appropriate zone/SLC and device number printed on cover.
3. Water flow devices must be initially adjusted to offer 30 second time delay for activation of alarm.
4. Each valve supervised must have a unique address and must be monitored individually.

C. Automatic (Smoke/Heat) Detectors:

1. Programmed for appropriate environment in which they are installed.
2. Solidly affix detector bases and secure to withstand rotary, tensile, and compressive movement that might occur during detector removal and insertion. Use electrical boxes with all devices capable of being mounted to electrical box. Support all detectors independently on false ceilings with T-bar hanger assemblies.
3. Detectors must not be installed before controlled environments are established well after finished trim out of building interior spaces that are protected by fire alarm system. Any devices contaminated by construction debris from premature installation must be discarded and replaced with new devices at no additional cost to the Government.
4. Automatic detector indicator LED lights must be visible from entry location of protected area.
5. Identify all detectors with zone/address number on exterior of detector base with sticker easily seen from floor level.

D. Remote Lamps:

1. Remote lamps/indicators must identify status of detectors that are located in concealed areas that are not visible from floor level.
2. When used, locate where readily visible by end user.
3. Mark remote lamps with same identification as detectors they represent.

E. Notification Appliances:

1. Visible Notification Appliances: Mount in accordance with NFPA 72.
2. Audible Notification Appliances: Mount in accordance with NFPA 72.

F. Fire Alarm Control Unit (FACU):

1. Install in room that has been approved by OBO/OPS/FIRE. Surface mount, with top of cabinet not more than 1800 mm (6 feet) above finished floor.
2. Install with 900 mm (3 feet) clearance in front of cabinet to open door for service.

G. Fire Alarm Annunciator Panel(s): Installed in locations that have been approved by OBO/OPS/FIRE. Surface mount at nominal 1500-mm (5-feet) above finished floor to top of the Display/Control Screen.

H. Line Isolation Modules: Isolation models must be installed in readily accessible locations as defined in NFPA 72. The location must be shown on shop drawing and record (as-built) drawings.

3.5 WIRING INSTALLATION

A. Methods:

1. Provide dedicated raceway/conduit system solely for fire alarm wiring.
2. Primary power circuits supplied to fire alarm system must not be in the same conduit, raceway or cable tray with fire alarm circuits.
3. T-tap connections are not allowed for fire alarm circuits.
4. Circuits must minimize penetrations (i.e., one penetration in and one penetration out) through physical security hard line walls and other special walls.
5. Conductors must be sized so voltage drop does not exceed 10 percent of nominal voltage. (i.e. strobe circuits) at end of circuit.
6. All wire must be free from any mechanical failures (e.g., open circuits, shorts between conductors or shorts to earth ground).
7. Observe direct current polarity: Black insulated wire must be negative, red must be positive.
8. Provide dedicated SLC at each floor.
9. Outgoing and return cables must have minimum separation of 300 mm (12 in.) where cable is installed vertically, and 1.22 m (48 in.) where cable is installed horizontally.

B. Wire Marking:

1. Wire numbers must correspond with circuit numbers and designators (e.g., SLC #17 must be connected to Signaling Line Circuit #17).
2. Signaling Line Circuits must be labeled ‘SLC’. ‘SLC’, Notification Appliance Circuits must be labeled ‘NAC’. Indicating Line Circuits must be labeled ‘IDC’.
3. Mark all spare wire with numbers beginning with 200.

4. Color-code fire alarm conductors differently from the normal building power wiring. Color-code audible alarm notification appliances differently from alarm-initiating device circuits. Use different colors for visual alarm notification appliances.

C. Fiber Cable Marking:

1. Interior Marking:

   a. Inside Each Fire Alarm Control Unit (FACU): Mark each jacket with the Node # (a panel inside the building), the building the individual fiber is going to, or in the patch panel it is going to before leaving the building.
   b. Inside Each Fiber Patch Panel: Mark each jacket with the building Node # or the building it communicates (connects) with.

2. Exterior Marking:

   a. Exterior fire alarm fiber cabling must be clearly identified as 'Fire Alarm.' Where installed in duct banks, the cabling must also include which buildings the cabling/fiber is from as well as which building the cabling is from.
   b. Along the underground routes (all manholes, pull holes, Junction boxes, patch panels, etc.), the fire alarm network cables must be permanently marked indicating: (1) that the cable is Fire Alarm (i.e., RED stripes) and (2) the routing (e.g., SDA3 to Post One).

3. All fiber optic cable jackets must be permanently marked at each end to identify the buildings or nodes connected and must conform to the following:

   a. Outside Plant Cable: Provide building acronyms for each building any given cable serves (e.g. "OBC" – "NOB").
   b. Inside Cable: Provide node descriptions for each panel served (e.g., "Node1" – "Node 2").

D. Splices/Terminations:

1. Shielded cable must not be used for NAC, SLC, or IDC wiring, unless otherwise recommended by manufacturer.

   a. Where shielded wiring is recommended by manufacturer, all shielding wiring must be installed in accordance with manufacturer's recommendations.

2. Connect conductors to numbered terminal strips in junction, pull, or outlet boxes, cabinets, or equipment enclosures.
3. There must be no field splices. Circuits are to be continuous from device to device, with terminations only on the device itself.
4. Mark each terminal according to wiring diagrams of system.
5. Make all connections in an approved manner.

6. Install conductors parallel with or at right angles to sides and back of enclosures.
7. Bundle, lace, and train conductors to terminal points with no excess lengths.
8. Wire nuts are not permitted to be used.

E. Risers and Network Communications:

1. Provide all network communications in dedicated conduit.
2. Provide Class X network communications with separate conduit paths conforming to survivability requirements of this specification.

F. Between Buildings:

1. When Primary FACUs are required in separate buildings; connect between buildings with fiber optic network communications using fiber patch panels.
2. Provide Class X circuits between buildings. Each network path (primary and redundant) must be in a separate conduit and trench if available. Where located in a single duct bank, each network path must be remote to the maximum extent possible.
3. Provide proper surge protection where copper conductors exit and enter buildings.
4. For wiring and pathways between buildings, (whether by direct burial, over head or on the surface of a wall), both the pathway as well as the conductor must be rated and installed to prevent moisture from entering.

G. Grounding:

1. Ground equipment conductor and cable shields. Shielded FPL cable must have shields or drain wire tied through devices and junction boxes and isolated (insulated) from ground except at the FACU.
2. Grounding for outdoor locations must comply with Chapter 2 of the Electrical Code of Overseas Buildings Operations.

3.6 CONDUIT

A. Minimum conduit size must be 19 mm (¾-inch).

B. The number of conductors in any conduit must meet the requirements of Article 760 and Chapter 9 (Tables 1 and 4) of NFPA 70 (model National Electrical Code).

C. Install junction/pull boxes such that there are no more than equivalents of four quarter bends (360 degrees total) between pull points.

D. Install intermediate junction/pull boxes as necessary.

E. Seal all conduit penetrations through fire rated walls, corridor walls, and mechanical/electrical room walls with fire rated sealant.

F. When multiple buildings are to be connected by conduit runs, and conduit is exposed to the elements or buried underground, the conduit must be rigid metal or rigid nonmetallic conduit.

G. Where the conduit is exposed to adverse climatic conditions, provide weatherproof conduit, electrical boxes and connectors.

H. All conduit must be routed parallel or perpendicular to the structure and must be concealed to the greatest extent possible concealed.

3.7 JUNCTION BOXES

A. All Junction Boxes:

1. Make terminations inside junction box in accordance with NFPA 70 (model National Electrical Code).
2. Label and identify wiring with zone/SLC/NAC it represents.
3. Paint junction boxes red, including the cover.
4. Label boxes using stenciled exterior lettering in white or silver paint “FIRE ALARM WIRE ONLY.”

B. Fire Alarm Terminal Cabinets (FATC) or Riser Junction Boxes: In addition to above:

1. Locate boxes in locked electrical spaces.
2. Boxes must be readily accessible for maintenance personnel.
3. Cover must be hinged, hasped, and have common lock, using same key as main fire alarm system FACU.
4. Assign a number to each FATC riser junction box. Numbers must correspond to floor location (e.g., "FATC BOX NO. 0" is in basement, "FATC BOX NO. 1" is ground floor, "FATC BOX NO. 2" is on second floor). Label junction boxes accordingly.
5. FATCs must have wire listing on inside cover based on wire terminations and must be located above finished floor where extra equipment such as ladders are not necessary for access.
6. Boxes must be 300 x 300 x 100 mm (12 x 12 x 4 inches) minimum, sized appropriately according to number of conductors contained within, and contain terminal strips for wiring connections.

C. Fiber Interface Cabinets (Patch Panels)

1. Each FACU requiring a fiber optic network connection must be furnished with a fiber interface panel. The patch panel must be labeled and must be located in easily accessible location. Patch panels above the ceiling are not permitted. The panel must be Corning WCH-02P or equal. Fiber in and out of each termination cabinet must be 6 strand. All fibers must be terminated, tipped, and tested. Jumpers between the fiber interface panel and the FACU must be provided with mechanical protection.

3.8 FIELD QUALITY CONTROL

A. Periodic Inspection: NICET Level III, NICET Level IV, or QFPE must perform inspection on the work at intervals of no greater than 60 days during the duration of the fire alarm system installation. Submit written inspection reports to OBO/OPS/FIRE/FPE for review. 60 days will be based on Schedule and progress reports required in the Part 1 Article on QUALITY ASSURANCE.

3.9 PRE-TESTING

A. Pretesting and Commissioning: The entire fire alarm system must be satisfactorily pre-tested by Contractor prior to request for final acceptance tests. Correct all deficiencies prior to final acceptance tests. Activities must be performed by factory-authorized service representative.

1. OBO/OPS/FIRE must be present during final performance testing to witness and has role of accepting successful operation of fire alarm systems.

B. Upon completing installation of system, conduct start-up and complete performance testing in accordance with manufacturer's requirements and NFPA 72, except that magnet tests are permitted.

C. Verify that requirements of Contract Drawings, Contract Specifications, and NFPA 72 are met.

D. Contractor is responsible for having equipment on-site for testing system, including test smoke for smoke detectors, sound pressure level meters (conforming to NFPA 72), heat gun for heat detectors, method to reach all detectors (smoke pole, ladder and / or lift) and minimum of three two-way radios for communication. Multi criteria detection devices must be tested with test equipment designed to emit heat and smoke simultaneously. It is not acceptable to use any flame producing or smoke producing items such as cigarettes, cigars, or pump sticks.

E. Correct all deficiencies observed in pre-testing.

F. Required Personnel. Pre-Testing must be performed by the lead installer along with other required personnel.

G. Test in accordance with procedures outlined in NFPA 72. The testing must consist of the following:

1. Verify absence of unwanted voltages between circuit conductors and ground.
2. Test and verify all circuits meet capacitance and resistance ranges and values according to manufacturer's instructions and recommendations.
3. Test all initiating and indicating circuits for proper responses under alarm, trouble, open circuit, shorted, and grounded conditions. Observe and record control unit responses to each circuit condition.

4. Test smoke detectors according to manufacturers approved methods and record sensitivities in accordance with NFPA72.
5. Test complete system for fire safety functions according to system design and specifications; observe and record responses. Note this must include all connected systems and control functions. Observe and record indicating lights, displays, signal tones, and annunciator indications.
6. Test all primary power, secondary power, and batteries. Verify batteries are sized to operate system for period and in manner specified.
7. Retain test equipment and special tools at site until performance testing is completed and system is accepted by OBO/OPS/FIRE through the Project Director/COR.
8. Record of complete successful pre-test must be submitted to OBO/OPS/FIRE through the Project Director/COR minimum of 30 days prior to requested final acceptance test date. This must include completed NFPA 72 certificate of completion, documentation of all required activities listed herein and activity log of fire alarm main panel as proof that 100 percent of the devices, connected systems and control functions were tested.

3.10 CLEANING AND ADJUSTING

A. Cleaning: Initiating devices must not be cleaned. Any devices contaminated (e.g., by construction debris, dust) must be discarded and replaced with new devices in conformance to requirements for automatic (smoke/heat) detector installation timing and non-contamination in the Part 3 Article on EQUIPMENT INSTALLATION.

3.11 POSTED INSTRUCTIONS AND INFORMATION

A. Mount operating instructions at FACU (Frame and Post).

B. Panel Information: Provide the following information at the Main FACU:

1. Label to identify electrical distribution panel and circuit breaker number for primary power serving the FACU and Date(s) of installation.
2. A copy of the “Records of Completion.”
3. CD/DVD with final system program.

3.12 OBO/OPS/FIRE PROGRESS INSPECTIONS, COMMISSIONING, AND ACCEPTANCE

A. Progress Inspections: OBO/OPS/FIRE personnel conduct routine site inspections of fire alarm and connected systems during construction. There are generally three progress inspections that occur; these are at approximately the 40-50 percent, 75 percent, and 90-100 percent completion stages of overall project.

1. At the time of any inspection, OBO/OPS/FIRE must be provided with access to any and all inspection reports made by certified or licensed fire protection professionals as required by contract.
2. The system installation contractor and General Contractor must keep current on file all NFPA inspection and test reports for inspection by OBO/OPS/FIRE personnel during these inspections.
3. All deficiencies identified to contractor must be promptly remedied.

B. Final Inspection, Testing and Acceptance: OBO/OPS/FIRE personnel will conduct one final site inspection, testing, and acceptance visit.

1. Scheduling of Final Inspection, Testing, and Acceptance:

   a. Scheduling of final inspection is not permitted until the building(s) are substantially completed, pre-testing has been completed, and any noted deficiencies have been corrected.
   b. The General Contractor must request to schedule the final inspection in accordance with Division 01 requirements with a minimum of 30 days in advance of proposed date to allow for coordination by OBO/OPS/FIRE.
   c. The General Contractor must submit the completed affidavit titled “Fire and Life Safety Systems Request for Final Acceptance Test” signed with the requested inspection date. The form is attached to this specification and available from OBO/OPS/FIRE. Refer to Part 1 Article on SUBMITTALS.
   d. Required pre-test data and documents must be submitted to OBO/OPS/FIRE through the Project Director/COR.

2. OBO/OPS/FIRE requires 14-day Burn-in period for all fire alarm systems and networks prior to final inspection, testing, and acceptance.

   a. All installation, programming, and testing requirements must be completed prior to initiating the burn-in period.
   b. No system modifications, programming changes, testing, or training must occur during this time.
   c. All events occurring on the system during burn-in must be recorded, documented, and submitted to OBO/OPS/FIRE within 24 hours of each event.

C. When requesting final inspection, general contractor must submit, with requested inspection date, the completed affidavit titled “Fire and Life Safety Systems Request for Final Acceptance Test” signed as indicated on that form. The form is attached to this specification.

D. Programming Changes During Testing: Where programming changes are made during course of acceptance testing/commissioning, testing will restart until system can be 100 percent tested without any programming changes occurring.

E. Contractor is responsible for having equipment on-site for testing system, including, but not limited to test smoke for smoke detectors, sound pressure level meters (conforming to NFPA 72),

heat gun for heat detectors, method to reach all detectors (smoke pole, ladder and / or lift), and minimum of three two way radios for communication approved for use by the Site Security Manager (SSM) or Regional Security Officer (RSO). Multi criteria detection devices must be tested with test equipment designed to emit heat and smoke simultaneously. It is not acceptable to use any flame producing or smoke producing items such as cigarettes, cigars or pump sticks. Use of magnets is not permitted during final acceptance testing.

F. Contractor is responsible for having lead installer and qualified individual present for the duration of final inspection and final testing. Where lead installer and qualified individual are the same person, the Contractor must have at least one additional person qualified at NICET II level during testing for a total of two NICET certified individuals provided by the Contractor. The qualified individual or NICET II level individual will be controlling the main FACU and communicating with lead installer via two-way radio conducts functional tests on each device. OBO/OPS/FIRE personnel must witness testing all aspects of testing. Where OBO/OPS/FIRE personnel have to perform testing due to lack in qualified people provided by the Contractor (as defined in this specification), OBO reserves the right to charge the General Contractor for time and travel expenses for each OBO team member. All fire alarm control units must have factory set passwords active during acceptance testing; they must remain active throughout acceptance period and the period when the system is placed in service.

G. If the project is not substantially complete in accordance with the documentation required in this Section, OBO reserves the right to charge the General Contractor for additional time and travel expenses required by OBO/OPS/FIRE for subsequent inspection.

3.13 TRAINING

A. Training: Training must not be conducted until fire alarm system installation, including fire alarm system monitoring, has been tested in accordance with NFPA 72, and accepted by OBO/OPS/FIRE.

1. The lead installer must provide two separate eight-hour operational maintenance / troubleshooting training sessions on the fire alarm system to Government personnel, including Foreign Service National (FSN) maintenance personnel, MSG, and PCC Tenants on location.
2. Training must include classroom and practical hands-on training covering operation, adjustments, theory, and troubleshooting.
3. Specific operation maintenance manuals, as described within the Part 1 Article on SUBMITTALS (in paragraph on Operation and Maintenance Manuals), must be utilized for this training.
4. Produce video of training, and submit as DVD deliverable, so that future staff may benefit from the training sessions.

END OF SECTION 284626

SECTION 284705 – MASS NOTIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Emergency Notification System (ENS).
2. Imminent Danger Notification System (IDNS).

B. Related Sections include the following:

1. Section 280508 “Common Work Results for Technical Security Systems (TSS)” for requirements common among TSS system type, and for TSS system racks and interaction with TSS electrical infrastructure.
2. Section 283337 “Technical Security Duress Systems” has no connection with the mass notification system.
3. Section 285115 “Security Management System Enterprise (SMSe).”

1.2 SYSTEM DESCRIPTION

A. Emergency Notification System (ENS):

1. ENS provides audible alert in event of imminent danger to personnel. When activated, personnel are intended to take necessary steps to protect life, information, and property.
2. ENS reports tone activations via Security Management System enterprise (SMSe).
3. ENS system is not to be used as public address system.
4. ENS system uses call station keypads for user interface points.
5. ENS system interfaces with Night Bell Paging Adapter.
6. ENS system must be 15db above ambient noise

B. Imminent Danger Notification System (IDNS):

1. Imminent Danger Notification System (IDNS) immediately alerts building and compound occupants to threat via activation of hardwired switch or remote pendant.
2. IDNS devices activate Emergency Notification System (ENS) “Duck & Cover” tone and voice instructions.
3. IDNS as a whole is not part of ENS; however, the two systems function in unison to inform personnel of imminent danger.
4. Security personnel who perceive plausible, imminent threat are intended to trigger IDNS through one of two methods:

a. Switches and wireless transmitter pendants.
b. Repeaters to transmit pendant signals.

1.3 SUBMITTALS

A. Product Data: Include components, rated capacities, operating characteristics, furnished specialties, dimensions, finishes, and accessories.

B. Shop Drawings: Details assemblies of standard components that are custom assembled for specific application on this Project.

C. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are not acceptable.

D. Contractor QC Pre-Check Certification: Refer to Section 280508 "Common Work Results for Technical Security Systems (TSS) for combined certification for contractor QC for all TSS sub-systems

E. Operation and Maintenance Data: Include the following:

1. Operating and maintenance instructions.
2. Operating sequences.
3. Purchase source for operating and maintenance materials.

1.4 QUALITY ASSURANCE

A. Perform quality control in advance of QA checks by the Government in accordance with Article on QUALITY ASSURANCE in Section 280508 "Common Work Results for Technical Security Systems (TSS)."

PART 2 - PRODUCTS

2.1 GENERAL

A. Approved Products: See separate contract attachment, "DS TSS Equipment List" for a partial listing of products that have been approved for general use in DOS overseas facilities.

B. Emergency Notification System (ENS):

1. Controller:

a. Primary control component for ENS.
b. Provides digital audio to amplifiers and stores digital messages and tones.
c. Interfaces with call station, call station interfaces and amplifiers via CAT5, glass fiber, and proprietary plastic fiber cables.
d. Provides outputs for interfacing with IDNS.

2. Speakers and Horns:

a. Ceiling mounted and wall mounted.

3. Controller: Load ENS controller with three different audio files:

a. “State Department Message # 1 (Duck and Cover).”
b. “State Department Message #2 (Evacuate).”
c. “State Department Message #3 (Retreat).”

4. Program Audio Router for standard zone control as follows:

a. NOB.
b. CAA.
c. MSGR/CMR.
d. Site Buildings.
e. Exterior horns.

5. Safe Haven:

a. Provide control unit and microphone.
b. Cut-off switch for IDNS.
c. Volume control for speakers in Safe Haven.
d. Post 1 override.

6. Safe Area:

a. Provide volume control for speaker inSafe Area.

7. Provide separate and dedicated power supply for each control unit(s).

C. Imminent Danger Notification System (IDNS):

1. If RF Repeater is provided, it must contain tamper switch, which reports to Standard IDS annunciator panel in Post 1.

PART 3 - EXECUTION

3.1 INSTALLATION – SYSTEM- SPECIFIC

A. Emergency Notification System (ENS):

1. Do not install ENS speakers in stairwells.
2. Loop ENS speaker circuit cable from speaker to speaker.
3. Zone speaker circuits to allow Marine Security Guard to activate and deactivate ENS on a building-by-building.

a. .

B. Imminent Danger Notification System (IDNS):

1. Install hardwired switches at all PACs and CAC screening areas and guard booths and provide transmitters in accordance with Table 3.1, "IDNS System."

TABLE 3.1
IDNS SYSTEM

DESCRIPTION/LOCATION	DUCK AND COVER SWITCH
CAC Guard Booths	1
PAC Screening Areas	1
PAC Guard Booths	1
Truck Transfer Screening Area	1
NOB/NOX Service Entrance Screening Area	1
NOB/NOX Service Entrance Guard Booth	1
Consular Screening	1

2. Install hardwired DP/ST switches to activate primary alert tone (ENS Message #1) on ENS control unit and a zone on Standard IDS annunciator panel. This will provide location identifier.
3. Mount remote activation switches/buttons in discreet locations out of public view. Install with switch guard to prevent accidental activation, and clearly label switch guard.

4. Install system so that roving guards carrying transmitter can trigger IDNS tone from any location on compound perimeter. Provide 10 programmed and tested pendants to the RSO or PD.
5. Programming for wireless pendants at CACs must uniquely identify guard locations to MSG Post 1.
6. Lock and Leave Posts: Place RF receivers for wireless pendants in Post 1 or remote CAC guard booth; when placed in CAC, hardwire receiver to ENS in chancery.
7. Refer to separate contract attachment "Technical Security (TS) Application Guidelines" for the systems identified below for detailed installation instructions and adjustments to manufactured systems.

    a. Inovonics Wireless System – Installation for IDNS.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Representative: Engage factory-authorized service representative to inspect field assembly and connection of components, and to test functioning of system.

1. Perform these quality control procedures prior to Quality Assurance inspection by the Government.

3.3 DEMONSTRATION

A. Engage a service representative to train Government personnel to adjust and operate security equipment. Refer to Division 01 Section "Demonstration and Training."

1. ENS.
2. IDNS.

END OF SECTION 284705

SECTION 284800 AREAS OF REFUGE EMERGENCY COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies intercommunication systems at Areas of Refuge.

B. Related Sections:

1. Other Divisions 26 and 27 sections for conduits, wire ways, connection boxes, pull boxes, junction boxes, and outlet boxes permanently installed in walls, floors, and ceilings, and for interface with panelboards to power each intercom.
2. Section 283325 “TSS Intercommunications Systems” for post security personnel communication with other security personnel, and post security personnel interface for remote access control.

1.2 CODES AND STANDARDS

A. Codes and standards referenced in this Specification must be those editions referenced in the applicable version of the OBO Building Codes (OBO adopted codes and OBO Code Supplements) and references cited in those Codes, or those current at the date of this Specification, unless otherwise noted.

B. In the event of a conflict between referenced codes and standards and/or the Drawings and Specifications, the code or standard having the more stringent requirements must govern.

C. Comply with the following industry Standards, unless more stringent requirements are indicated or are required by an approved product manufacturer:

1. National Fire Protection Association (NFPA):

   a. NFPA 72, “National Fire Alarm and Signaling Code,” 2022 edition

2. Underwriters Laboratory (UL)

   a. UL 2525, Two-Way Emergency Communications Systems for Rescue Assistance

3. International Code Council (ICC) / American National Standard (ANSI)

   a. ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities

1.3 SYSTEM DESCRIPTION

A. System Elements: The system must comprise a command unit station, remotely located communications stations (remote call stations), primary and secondary power supply, and signage.

1. Main Unit Station: Main operator's control device, which includes audible and visual display to indicate specific active remote call station location(s). Located in Post 1.
2. Remote Call Station (call boxes): Located at each Area of Refuge (typically stairwells) and communicate directly to the Main Unit Station in Post 1. Communication must be analog (no exceptions).
3. Signage: Elements locating each designated Area of Refuge and notification system, including instructions on how to operate Remote Call Station.

B. System Operation: When an occupant(s) activates a remote call station(s), a two-way live voice communication must operate between the remote call station(s) and the Main Unit Station located in Post 1.

C. This project is a ring-and-string project; that connectivity must be provided as work of this section.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and equipment data for all proposed equipment, devices, wire, conduit to be incorporated in the project. Where multiple items are shown on data sheets, product data sheets must be marked up (circled, highlighted, or strike through) to indicate which items will be used/provided and which items will not be.

B. Shop Drawings: Prepare code compliant working plans according to NFPA 72. Shop drawings must be consistent with construction drawing set, including plans, schematics, and diagrams, which indicate locations and arrangement of command unit stations, each remote call station, wiring, power supply, and signage.

C. System Test Performance Confirmation: Provide notification that each system location has been tested in accordance with the Article on FIELD QUALITY CONTROL, and that each system location conforms to the requirements for function and performance identified in this Section.

D. Operations and Maintenance: Submit completed record of manufacturer's operations and maintenance manual, including manufacturer's data sheets and installation instructions for installed equipment. Include testing and maintenance schedule and procedures. Provide complete operating instructions and repair/troubleshooting guide listing common causes for breakdowns, malfunctions, and recommended repairs. List spare parts and replacement parts as well as suppliers. Provide copies of NFPA 72 and drawings identifying location of command unit station, all remote call stations, wiring pathways, and signage.

1.5 QUALITY ASSURANCE

A. Manufacturer, Supplier, and Installer Qualifications:

1. The term "manufacturer" is defined as a firm regularly engaged in the manufacture and integration of intercommunication system components, of types and ratings specified and indicated, whose products have been in satisfactory use in similar services for not less than five years.
2. All command unit installation, configurations, setup, program and related work must be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver assemblies, components, and accessories to job site in undamaged factory packaging.

B. Inspect all items upon delivery to job site.

C. Storage of active equipment:

1. Do not deliver to site more than six months prior to final commissioning.
2. Store in temperature-controlled room or container in accordance with manufacturer’s recommendations.

D. Store cabling, consumables, electronics, and batteries away from moisture, dust, and static electricity.

1. Store these items in location that maintains temperature between 10 deg C (50 deg F) and 30 deg C (85 deg F), and humidity between 30 and 70 percent.

1.7 PROJECT CONDITIONS

A. Due to the sensitive nature of system components, items identified above as requiring environmentally controlled storage must only be installed when environmental controls and power are operational to maintain those environmental conditions in spaces where those items are installed, and other work in those spaces is approximately 90 percent complete.

1.8 COORDINATION

A. Coordinate the work in this section with other sections as required ensuring that the entire work will be carried out in orderly, complete, and organized fashion.

B. Coordinate with other trades for installation of backbone cabling such as mechanical, electrical, and structural.

PART 2 - PRODUCTS

2.1 GENERAL

A. All cables in this Section must conform to TIA standards cited in Section 270508 "Common Work Results for Telecommunication."

B. Overall system must comply with UL 2525 "Two-way Emergency Communications Systems for Rescue Assistance."

2.2 MAIN UNIT STATION

A. Description: Area of Refuge analog main unit station.

1. Built-in local main unit phone for on-site calling with no outside phone line.
2. Monitoring panel providing audible and visual indication (strobe/sounder) when emergency call is detected.
3. Support and provide power to each analog remote call station as an area of refuge (or area of rescue assistance) station used for emergency communications.
4. Specific location of each active remote call station must be identified on the Main Unit Station display on a floor and area basis.
5. Steel enclosure cabinet with acrylic windows.
6. Located in Post 1.

B. Basis-of-Design System: Talkaphone, AOR-16

1. Area of Refuge Analog Station: AOR-CSE-FM

2.3 REMOTE CALL STATIONS

A. Description: Analog, hands-free operated, ADA-compliant communication endpoint.

1. 2-way hands-free communication with push button once to call.
2. Phone line powered: no power supply or battery backup
3. Two LED indicators for hearing impaired (calling, answered)
4. Flush mount configuration.

B. Basis-of-Design System: Talkaphone, AOR-CSE-FM

2.4 AREA OF REFUGE SIGNAGE

A. Description: Signage to designate each Area of Refuge.

1. Constructed of UV light-resistant polycarbonate.
2. Self-adhesive sign.
3. ICC A117.1 raised lettering and Braille for ADA-compliance.
4. Signage must be located adjacent to each door providing access into an Area of Refuge.
5. Signage must be in English and local language.

B. Basis-of-Design System: Talkaphone, ETP-SIGN

2.5 REMOTE CALL STATION SIGNAGE

A. Description: Signage providing operating instructions for remote call stations.

1. Constructed of UV light-resistant polycarbonate.
2. Self-adhesive sign.
3. ICC A117.1 raised lettering and Braille for ADA-compliance.
4. Signage must be located adjacent to each Remote Call Station.
5. Signage must be in English, local language, and use internationally accepted graphic symbols.

B. Basis-of-Design System: Talkaphone, ETP-SIGN

2.6 SECONDARY POWER SUPPLY

A. Systems must be capable of operating the system under quiescent load for a minimum of 24 hours and then subsequently during a fire or other emergency condition for a period of 4 hours with all remote call stations activated and all main unit stations annunciating the calls.

2.7 PATHWAYS

A. The remote call stations and the main unit station must communicate with each other via pathways based on their performance capabilities under abnormal (fault) conditions in accordance with the requirements for Class A, Class B, Class N, or Class X pathways specified in NFPA 72, Chapter 12.

B. All pathways between the remote call stations and the main unit station must be monitored for integrity.

2.8 DISPLAY LOCATION INFORMATION

A. The specific location of each active remote call station must be identified on the main unit station display on a floor and area basis in accordance with the following:

1. Where all active calls are not simultaneously displayed, the main unit stations must provide the following:

a. Previously answered calls must be capable of being prioritized as urgent on the main unit station to differentiate more urgent life safety related calls from less urgent calls.
b. A minimum of 8 active call station identifiers must be visible in the following order of priority:

1) Previously unanswered calls, oldest first.
2) Previously answered calls, prioritized as urgent, oldest first.
3) Previously answered calls, not prioritized as urgent, oldest first.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate equipment work with the work of other Sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work. Furnish installation templates, diagrams, and other data to fabricators and installers of related work as necessary for coordination of the installation. Place such items, including pipes, conduit, inserts and anchors, accurately in relation to the final location of equipment components.

B. Install all components of the equipment in accordance with the manufacturer's written instructions and recommendations.

3.2 FIELD QUALITY CONTROL

A. Contractor must perform tests to verify proper operation of main unit station and each remote call station.

3.3 TRAINING

A. Training: Training must not be conducted until area of refuge emergency communication system installation has been tested in accordance with NFPA 72 and accepted by OBO/OPS/FIRE.

1. The lead installer must provide two separate operational maintenance and troubleshooting training sessions on the area of refuge system to Government personnel, including Locally Employed Staff maintenance personnel and MSG on location.
2. Training must include classroom and practical hands-on training covering operations, adjustments, theory, and troubleshooting.
3. Specific operation maintenance manuals, as described within Part 1.4 (Operations and Maintenance) must be utilized for this training.
4. Produce video of training, and submit as DVD deliverable, so that future staff may benefit from the training sessions.

END OF SECTION 284800

SECTION 285115 – SECURITY MANAGEMENT SYSTEM ENTERPRISE (SMSE)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Security Management System Enterprise (SMSe):

B. Related Sections include the following:

1. Division 087155 “Security Door Hardware.”
2. Division 26 for general electrical requirements.
3. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
4. Division 28 sections for TSS systems interfaced by the SMSe.

C. Access systems in Section 281005 “Technical Security Access Systems” are not tied in with the SMSe.

1.2 SUBMITTALS

A. Product Data: Include components, rated capacities, operating characteristics, furnished specialties, dimensions, finishes, and accessories.

B. Shop Drawings: Details assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify control interface devices. Describe characteristics of network and other data communication lines.

C. Equipment and System Operation Description: Include method of operation. Description must cover this specific Project; manufacturer’s standard descriptions for generic systems are not acceptable.

D. Contractor QC Pre-Check Certification: Refer to Section 280508 “Common Work Results for Technical Security Systems (TSS)” for combined certification for contractor QC for all TSS sub-systems.

E. Operation and Maintenance Data: Include the following:
1. Operating and maintenance instructions.

2. Data for each type of product, including features and operating sequences, both automatic and manual.
3. Parts inventory list.
4. Purchase source for operating and maintenance materials.

1.3 QUALITY ASSURANCE

A. Perform quality control in advance of QA checks by the Government in accordance with Quality Assurance requirements in Section 280508 "Common Work Results for Technical Security Systems (TSS)."

1.4 DELIVERY AND STORAGE

A. Refer to Section 280508 "Common Work Results for Technical Security Systems (TSS)" for storage and protection.

PART 2 - PRODUCTS

2.1 GENERAL

A. Approved Products: See separate contract attachment, "DS Approved Equipment List" for a listing of products that have been approved for general use in DOS overseas facilities.

2.2 SYSTEM DESCRIPTION

A. SMSe provides computer-based monitoring system that interfaces with TSS equipment via SMSe Network. The system allows network to monitor security equipment performance and provides diagnostics capabilities.

B. SMSe Network monitors/integrates with the following standard TSS:

1. Intrusion Detection Systems (IDS).
2. Network Video Recorders (NVR) for Security Video System (SVS) monitoring.
3. Automated Access Control Systems (AACS).
4. Emergency Notification System (ENS).
5. EC Room Environmental sensors.
6. EC Room Uninterruptible Power Supply (UPS) with Ethernet module.
7. Automated Key Control Systems (AKCS) with Ethernet module (NOB and NOX only).

2.3 EQUIPMENT

A. Automated Access Control System (AACS): Panels and readers.

B. Global Identification (GLID) system and accessories:

1. Badging Workstation
2. Widescreen Flat Panel LCD Monitor.
3. Camera.
4. Tripod for camera.
5. Backdrop Screen.
6. Badge Printer with magnetic stripe encoder and holographic lamination module.
7. Associated supplies, uninterruptible power supplies (UPS), and cabling.

C. SMSe workstation monitors for Post 1, Main EC Room, Regional Security Office (RSO), Safe Area EAP, and Engineering Service Center (ESC) office.

D. Infrastructure associated with system; see Section 280508 Common Work Results for TSS Systems."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Automated Access Control System (AACS):

1. AACS Readers: Install card reader with PIN pad as identified in Table 3.1, "AACS Readers."

TABLE 3.1: AACS READERS

LOCATION	DESCRIPTION
NOB Entrance(s) Exterior Hardline	Main NOB and Service Entrance
NOB Entrance(s) Interior Hardline	Hardline doors that allow access from public space to General Work Area (GWA)
CAA Perimeter	GWA primary and secondary access to CAA Buffer
Main EC Room	Entrance to room
Room which holds AACS control panel (e.g. I.D. Badge Office)	Monitor AACS control panel (e.g., I-Star)

[Lock and Leave Bypass Door 1	**Not to operate door; only for record]**

2. AACS Control Panel (e.g., I-Star):

   a. Connect readers, reader outputs and door related inputs

3. AACS Control Sub-Panel:

   a. Provide separate enclosure with input boards and standoffs for connection to Enhanced IDS Controller**[and for Lock-and-Leave panel outputs]**.
   b. Provide three spare input boards

B. Global Identification (GLID) Badging Workstation:

1. Install GLID Badging workstation as server to establish temporary SMSe Local Area Network (LAN).
2. Install "EU" power to workstations, and do not use standalone UPS; see Part 3 Article on INSTALLATION – TSS PANELBOARDS in Section 280508 "Common Work Results for Technical Security Systems (TSS)."
3. Install Hardened Carrier System (HCS) infrastructure for non-encrypted SMSeNet local area network (LAN) signal lines transiting general work area (GWA), and lines from Main EC Room to spaces such as RSO and ESC office, Safe Haven EAP, and GLID I.D. Badging Office workstations, where those signal lines transit public access area (PAA).

C. Refer to Division 26 Section on wiring devices and Section 280508 "Common Work Results for TSS Systems" for outlets associated with SMSe.

D. Refer to separate contract attachments "Technical Security (TS) Application and Deployment Guidelines" for the SMSe identified below for detailed installation instructions and adjustments to modified manufactured systems.

1. SMSe Net.
2. SMSe I-Star/C-Cure Server.
3. Remote Video Integration.
4. SMSe Ancillary Devices.
5. Alarm Reporting.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Representative: Engage factory-authorized service representative to inspect field assembly and connection of components, and to start up and commission unit.

1. Perform these quality control procedures prior to Quality Assurance inspection by the Government.

3.3 DEMONSTRATION

A. Train Government personnel to adjust and operate the SMSe. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 285115

SECTION 311005 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing existing vegetation which are not indicated for protection.
2. Clearing and grubbing.
3. **[Stripping and stockpiling topsoil.]**
4. **[Stripping and stockpiling rock.]**
5. **[Removing above- and below-grade site improvements.]**
6. **[Disconnecting, capping or sealing, and [removing site utilities] [abandoning site utilities in place].]**

B. Related Requirements:

1. **[Section 311305 “Temporary Tree and Plant Protection”:**
2. Section 312507 "Temporary Erosion and Sedimentation Controls” for temporary control measures.

1.2 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than **[50 mm (2 inches)]** in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.

D. Plant-Protection Zone or Tree-Protection Zone: See Section 312507 “Temporary Tree and Plant Protection.”

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain the Government's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 [ACTION SUBMITTALS

A. [Topsoil stripping and stockpiling program: Prepare written program. Include dimensioned diagrams for placement and protection of stockpiles. Written program requires approval by Project Director/COR in terms of available usage of project site.]

B. [Rock stockpiling program. Prepare written program. Include dimensioned diagrams for placement and protection of stockpiles. Written program requires approval by Project Director/COR in terms of available usage of project site.]

C. [Burning permit. Permit from local authorities having jurisdiction indicating permission to burn, as well as identifying necessary protocols and documentation.]

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Coordinate with documentation in Section 311395 "Temporary Tree and Plant Protection." Indicate tree and plant protection zones, and their associated protective fencing.

B. Record Drawings: Identifying and accurately showing locations of utilities which were capped or were capped during site clearing, as well as other subsurface structural, electrical, and mechanical conditions identified during site clearing activities.

C. [Compliance with Burning Permit: Documentation of compliance with local burning requirements and with permitting of local authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.]

1.6 QUALITY ASSURANCE

A. Preinstallation (Pre-Execution) Meetings:

1. Consolidated meeting for general site clearing, temporary tree and plant protection if applicable, and temporary erosion and sedimentation controls.
2. Conduct at project site with Project Director/COR at least two weeks prior to any activity associated with the meeting.
3. Meeting topics shall include:

a. Approvals required by local authority having jurisdiction.
b. Existing improvements to be removed and to remain.
c. Existing utilities to be removed and to remain.
d. Required documentation.
e. Coordination with other work associated with the project.
f. Stockpiling programs for topsoil and rock, if applicable.

B. [Topsoil Stripping and Stockpiling Program: Prepare a program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work.]

C. [Rock Stockpiling Program: Prepare a program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work.]

1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining public and on-compound roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct those existing site elements without permission from Project Director/COR, and local authorities having jurisdiction for public where applicable.
2. Provide alternate routes around closed or obstructed trafficways if required by Project Director/COR or local authorities having jurisdiction, as applicable.

B. [Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Government's property will be obtained by Project Director/COR before award of Contract.

1. Do not proceed with work on adjoining property until directed by Project Director/COR.]

C. [Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Government's premises where indicated.]

D. Identify Existing Utility Locations: Notify utility locator service for area where Project is located before site clearing. If no such service is available,

E. Do not commence general site clearing operations until measures for temporary erosion- and sedimentation-control and for temporary tree **and plant-protection** (if applicable) are in place.

F. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section on "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. [Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [MPI #23 (surface-tolerant, anticorrosive metal primer)] [or] [SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating] <Insert requirement>.]

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. [Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged, and that associated protection zones have been identified and enclosed according to requirements in Section 311305 "Temporary Tree and Plant Protection."]

C. Protect existing site improvements indicated to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Project Director/COR.

3.2 EXISTING UTILITIES

A. [The Government will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.]

B. [Locate, identify, disconnect, and seal or cap utilities indicated to be removed [or abandoned in place].

1. [Arrange with utility companies to shut off indicated utilities.]
2. [The Project Director/COR will arrange to shut off indicated utilities when requested by Contractor.]

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by the Government or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Project Director/COR not less than five days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Project Director/COR's written permission.

E. [Excavate for and remove underground utilities indicated to be removed.]

F. [Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Division 02 Section(s) on "Structure Demolition" and "Selective Demolition."]

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 75 mm (3 inches) in diameter, obstructions, and debris to a depth of 450 mm (18 inches) below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated. Coordinate with Division 31 Section on "Earth Moving."

1. Place fill material in horizontal layers not exceeding a loose depth of 200 mm (8 inches) and compact each layer to a density equal to adjacent original ground.

3.4 [TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth indicated on Drawings, or otherwise to depth of 150 mm (6 inches), in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects larger than 50 mm (2 inches) in diameter; trash, debris, weeds, roots, and other waste materials.

C. [Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 1800 mm (72 inches).
2. Do not stockpile topsoil within protection zones.

3. [Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.]
4. [Stockpile surplus topsoil to allow for respreading deeper topsoil.]

3.5 [STOCKPILING ROCK

A. Remove from [area indicated on Drawings] naturally formed rocks that measure more than 300 mm (12 inches) across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 50 mm (2 inches) in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock [where indicated on Drawings] without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to 900 mm (36 inches).
2. Do not stockpile rock within protection zones.

3. [Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.]
4. [Stockpile surplus rock to allow later use by the Government.]]

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Government's property.

B. [Where permitted by local authorities having jurisdiction, burn tree, shrub, and other vegetation waste in accordance with the permit requirements. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.]

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311005

SECTION 311305 – TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general protection and pruning of those existing trees and plants which are intended to remain, and that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:

1. Division 01 Section "Temporary Facilities and Controls" for general temporary site fencing.
2. Section 311005 "Site Clearing" for removing those existing trees and shrubs which are not intended to remain.
3. Section 312000 “Earth Moving” for adjacent grading work, and for utility trenching and backfill.
4. Section 312507 “Temporary Erosion and Sedimentation Control” for coordination of temporary protection.

1.2 DEFINITIONS

A. Caliper (DBH): Diameter breast height; utilize measurement parameters of local or host country authorities. If no host country parameters apply, use diameter of a trunk as measured by a diameter tape at a height 1400 mm (54 inches) above the ground line.

B. [Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.]

C. Tree-Protection Zone: Area surrounding individual trees, tree stand, or forest to be protected during construction, as defined by local or host country authorities, if applicable, and [**indicated on Drawings**] [**defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated**] [**defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 2400 mm (96 inches) unless otherwise indicated**].

D. Tree Stands and Forest: As defined by local or host country authorities; if no definition is available, use the following:

1. Tree Stand: Any group of five or more trees in a 5000 sq. meter area, with no more than 5 meters separating any tree. Shrubs and vegetative growth between these trees are not included unless indicated on the Drawings.

2. Forest: In accordance with definition of American Forestry Association. For projects governed by the European Commission of the European Union in accordance with definition of professional trade publications. For projects in locales with bamboos or palms, the host country definition identification of whether these are considered trees apply; on a project-specific basis and where indicated on the Drawings, these may be considered trees even if the host country does not identify them in that manner. Where identified by host country standards, woody shrubs also are included in the definition of a forest.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

a. Tree-service firm's personnel, and equipment needed to make progress and avoid delays.
b. Project Arborist's responsibilities.
c. Coordination of Work and equipment movement with the locations of Tree- and Plant-Protection Zones.
d. Trenching by hand within Tree- and Plant-Protection Zones.
e. Field quality control.
f. Project enforcement procedures for Tree- and Plant-Protection Zones.

2. Construction Schedule.

a. Verify availability of materials, personnel, and equipment need to make progress and avoid delays.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Qualification Data: For Project Arborist. Include certifications and registrations, and three references for representative projects.

C. Samples: For each type of the following:

1. Organic Mulch: 1-Liter (1-quart) volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

D. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

E. Tree Protection and Demolition Plan: Plan must be prepared by Project Arborist and must identify all protection measures for existing trees and plants to remain. The approved Plan must be used by the Contractor to control construction activities within and adjacent to Tree- and Plant-Protection Zones, and exceptions are permitted only upon approval of both the Project Arborist and Project Director/COR. The Plan must identify:

1. Location of all tree and plant protection fencing, including locations of laydown and construction logistics that interface with protected areas.
2. Location of areas requiring special root zone protection and associated logistics.
3. Identification of any locations where specified root zone protection is not possible and identify alternate means of protection.
4. Locations of existing and new paving and concrete with Protection Zones.
5. Locations of grade change at edges of Protection Zones.
6. Location and nature of project work located within and adjacent to Protection Zones, including temporary service access and paths, and associated details and calculations.
7. Location of existing and new utility pathways, including associated trenching, within or adjacent to Protection Zones.
8. Surface and subsurface drainage and aeration systems. Identify interface with Section 312507 “Temporary Erosion and Sedimentation Control.”
9. Methodology and logistics for temporary and permanent landscape watering and irrigation for planting to remain.
10. Identify materials and schedule for mulching and fertilization with Protection Zones.
11. Identify procedures to prevent pollution from all sources.
12. Identify procedures to avoid disruption of environmental support of planting to remain which would result in loss of vigor.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For tree service firm.

B. Certification: From Project Arborist, certifying that trees and plants indicated to remain have been protected during construction according to recognized standards and the Tree and Plant Protection Plan, and were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From Project Arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Existing Conditions: Annotated plan documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or video recordings for annotation of plan.
2. Plans with associated notations must:

    a. Indicate specific wounds and damage conditions of each tree or other plants designated to remain.
    b. Show an accurate representation for trees with caliper of 200 mm (8 inches) or greater as measured at a height of 300 mm (12 inches).
    c. Identify botanical names of species.
    d. Identify canopy diameter of each tree to remain.

1.6 QUALITY ASSURANCE

A. Project Arborist Qualifications: Certified Arborist as certified by ISA**.** Licensed Arborist licensed or certified in local jurisdiction where Project is located, with minimum 5 years of successful commercial or institutional tree preservation projects in the locality or region of the project, and approved by Project Director/COR. Project Arborist must oversee on-site activity involving welfare of trees and plants to remain. Retain Project Arborist prior to on-site demolition and construction activities.

    1. Project Arborist must assist in preparation of submittals, such as documentation of existing conditions, to ensure appropriate detail.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project in the Project locale or region, and that will assign an experienced, qualified Project Arborist to the site during execution of the Work.

C. Standards: At a minimum, utilize standards required by local or host country authorities. Where no such standards are available, as well as to the degree that the following standards are more stringent, the following international standards apply in relation to protection of existing trees and plants:

    1. International Society of Arboriculture (ISA): *Guide for Plant Appraisal*; prepared by the Council of Tree and Landscape Appraisers (CTLA).
    2. ISA *Best Management Practices Series* (bundled with *ANSI 300 Guidelines*):

        a. *Best Management Practices Fertilization Combo*.
        b. *Best Management Practices Integrated Vegetation Management Combo*.
        c. *Best Management Practices Planting Combo*.
        d. *Best Management Practices Pruning Combo*.
        e. *Best Management Practices Support Systems Combo*.

1.7 FIELD CONDITIONS

A. The following practices are prohibited within Protection Zones. Exceptions are permitted only upon approval of both the Project Arborist and Project Director/COR.:

1. Cutting, girdling, over-watering, and excessive pruning of trees and planting to remain.
2. Poisoning of soil within and adjacent to Protection Zones.
3. Unscheduled and unauthorized relocation and transportation of trees and planting to remain.
4. Storage of construction materials, debris, or excavated material.
5. Paving within "root zone" of trees to remain.
6. Parking vehicles or storing equipment.
7. Foot traffic or vehicle traffic.
8. Erection of sheds or structures.
9. Impoundment of water.
10. Excavation or other digging unless otherwise indicated on Drawings. In no case is machine trenching permitted within or adjacent to Protection Zones.
11. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
12. Stockpiling or temporary storage of building materials, soils, dumpsters, or accumulated debris and refuse of excavated material is only permitted in accordance with the approved "Tree Protection and Demolition Plan," or where approved by the Project Arborist and Project Director/COR consistent with that Plan.
13. Use of tress as support posts, power poles, or signposts; anchorage for ropes, guy wires, or power lines; or similar functions.

B. Do not direct vehicle or equipment exhaust toward Protection Zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near Protection Zones and organic mulch.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings covered by the provisions of this Section that experience injury or fail to demonstrate flourishing condition of active growth, as determined by Project Director/COR with input from Project Arborist.

1. Failure for individual plants and for areas of groundcover requiring repair includes injury, unscheduled alteration, or death to 25 percent or less of each.
2. Failure for individual plants and for areas of ground cover requiring removal and replacement includes injury, unscheduled alteration or removal, or death to more than 25 percent of each, failure to demonstrate flourishing condition of active growth, damaged appearance that cannot be remedied with repair, or unscheduled removal.
3. Injury includes, but is not limited to, the following:

    a. Bruising, scarring, tearing, or breakup of root, trunk, branches, or foliage.
    b. Damage from herbicide or poisoning.
    c. Mechanical injury (i.e., non-infectious) due to landscape maintenance equipment, staking damage, vehicular traffic, vandalism, non-severe weather, insects, or animals.

4. Remove damaged vegetation as well as cuts and pruning associated with repairs and dispose off-site.
5. Replacement vegetation must match species and caliper of damaged vegetation, or may be of similar species with approval of Project Arborist
6. The warranty does not apply to transplanted vegetation.
7. Warranty Period: 1 year from date of Final Completion.

B. Plant Repair: Where repair is suitable remedy per parameters identified above, repair trees shrubs, and groundcover associated with the work of this Sections, and in a manner approved by Project Arborist.

1. Damage to tree crowns or roots of protected trees for trees over 50 mm (2 inches) in diameter must be reported to Project Arborist and Project Director/COR.
2. Submit details of proposed root cutting, and tree and shrub repair to Project Arborist, with copy to Project Director/COR.
3. Project Arborist must perform root cutting, branch pruning, and damage repair of trees and shrubs.
4. Treat damaged trunks, limbs, and roots in accordance with Project Arborist's written instructions, and under supervision of Project Arborist. Perform repairs within 24 hours.
5. Plant and maintain replacement trees, shrubs, and other vegetation as specified in Division 32 Section(s) on trees and plants.

C. Tree Replacement: Replace trees in accordance with parameters above.

1. General Replacement Tree Caliper: Caliper of replacement trees must be as follows:

a. Shade Trees: 100-mm (4-inch), 5 m (16 feet) tall.
b. Ornamental Trees: 50-mm (2-inch) at 250-mm (10-inches) above top of root ball, 2 m (8 feet) tall.
c. Palm Trees: 3.5 m (12 feet) to base of fronds.

2. Replacement Tree Quantities: Provide the following quantity of replacement trees per tree removed, and locate as directed by Project Arborist, with notification to Project Director/COR:

a. Caliper DBH up to 200-mm (8-inch): Three.
b. Caliper DBH between 200-mm and 600-mm (8-inch and 2-feet): Six.
c. Caliper DBH 600-mm (2-feet) or greater: Twelve.
d. Palm Trees: Three.

D. General Plant Replacement: Replace shrubs and vegetation in accordance with parameters above.

1. Replacement Shrub and Vegetation Size: Container or root ball size complying with ANSI Z60.1 for applicable type and form of plant.
2. Replacement Quantities: Provide three replacement shrubs per each damaged, removed, or altered shrub. Provide coverage of ground cover to match area requiring replacement. Locate as directed by Project Arborist, with notification to Project Director/COR.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Natural or cultivated top layer of soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or darker shade of brown, gray, or red than underlying subsoil; free of subsoil, clay lumps, gravel, and other objects more than 25 mm (1 inch) diameter, and free of weeds, roots, toxic materials, and other non-soil materials.

1. Existing topsoil of suitable quality may be stockpiled and mixed with new planting soil for use in limited regrading within Protection Zones.

B. Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of

1. Type: Shredded hardwood**.**
2. Size Range: 75 mm **(**3 inches**)** maximum**,** 13 mm **(**1/2 inch**)** minimum**.**
3. Color: Natural.

C. Protection Zone Fencing: Fencing fixed in position and meeting the following requirements: Previously used materials may be used when approved by Project Director/COR**.**

1. Chain-Link Protection Zone Fencing: Galvanized-steel fencing fabricated from minimum 50-mm (2-inch) opening, 3.75-mm- (0.15-inch-) diameter wire chain-link fabric; with pipe posts, minimum 60-mm- (2-3/8-inch-) OD line posts, and 75-mm- (2-7/8-inch-) OD corner and pull posts; with 4.5-mm**- (**0.175-inch-**)** diameter top and bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

   a. Height: 1800 mm (72 inches).
   b. Gates: Single**-** swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 900 mm **(**36 inches**)**.

2. Silt Fence Fabric: For specific temporary staging applications identified in the Article on ROOT MAT PROTECTION. Refer to Section 312507 “Temporary Erosion and Sedimentation Control.”

D. Protection Zone Signage: Shop-fabricated, rigid plastic or metal sheet, with attachment holes prepunched and reinforced; legibly printed with nonfading lettering, and as follows or as otherwise required by local or regional authorities:

1. Text:” TREE/LANDSCAPE PRESERVATION AREA – DO NOT ENTER”
2. Language: Provide message in both English and local language.
3. Lettering: 75-mm**- (**3-inch**)** high minimum, black characters on white background; block, all capital letters.

E. Ground Protection Mat Products:

1. General: Various triple-ply geo-composites consisting of inner permeable layer of high-density polypropylene construction attached to outer layers of non-woven permeable fabric.
2. Project-Specific Product Selection: Characteristics based upon site visit by Contractor's geotechnical specialist and Project Arborist.

    a. General factors considered in determining acceptable products must include characteristics of underlying soils, slope, drainage, erosion and sedimentation controls.
    b. Operational factors must be discussed on-site with Contractor's construction manager and Project Director/COR's representative. Factors considered must include, but are not limited to, anticipated equipment, staging, and stockpiling within protection zones, and frequency and duration of loading, and static versus dynamic loading. In addition, discussion must include interaction of operational factors with general factors.

3. Basis-of Design Products: The following products are approved for use with specific identified applications. Other products may be acceptable as determined by Contractor's geotechnical specialist and Project Arborist.

    a. Root Protection Matting (RPM) for protection from staging of greater than 24-hour duration and from foot and vehicle traffic: Tenax Tendrain 770/2.
    b. Root Aeration Matting (RAM) for protection of roots and soil with grade fills: Tenax Tendrain 770/2.
    c. Permanent mats at paving profiles: Tensar Triax TX5.
    d. Matting for staffing of 24-hour or less duration: AlturnaMATS.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspection of Protective Tree Fencing: Before construction activities commence for the project the protection fencing must be installed by the tree service firm and approved by the Project Arborist and Project Director/COR. The Project Arborist must provide a written statement verifying that they have conducted a field inspection of all trees, and that protective fencing conforms to the requirements of the Tree Protection Plan is in place.

B. Inspection of Rough Grading: The Project Arborist must perform an inspection during the course of rough grading adjacent to the Tree-Protection Zones, and must ensure trees will not be injured by compaction, cut or fill, drainage and trenching, nor injured by project-specific measures (as applicable) such as aeration systems, tree wells, drains, and special protection measures as identified in the Tree Protection Plan.

C. General Site Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place; refer to Section 312507 "Temporary Erosion and Sedimentation Controls." Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

D. Prepare written report, endorsed by Project Arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Conform to local and regional standards, where applicable.

1. **[Vegetation to remain have plant tags with identification numbers from previous survey. Confirm identification numbers with Drawings and replace missing plant tags to facilitate future identification.]**
2. Tie a 25-mm **(**1-inch) blue vinyl tape around each tree trunk at 1350 mm (54 inches) above the ground.
3. **[Flag each tree trunk to be relocated at 54 inches (1372 mm) above the ground.]**

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply 50- to 75-mm **(**2- to 3-inch**)** uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 450 mm **(**18 inches**)** of tree trunks.

3.3 TREE- AND PLANT-PROTECTION ZONES

A. Protection Zone Fencing: Install protection zone fencing along edges of Protection Zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F567 or local standards and with manufacturer's written instructions.
2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Project Director/COR.
3. Access Gates: Install where indicated**,** or otherwise unlikely to be blocked by material storage or side of fence opposite activity; adjust to operate smoothly, easily, and quietly; free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
4. Keep gates chained and padlocked at all times other than to gain entry for useful purposes related to tree and plant protection.

B. Protection Zone Signage: Install Protection Zone signage in visibly prominent locations in a manner approved by Project Director/COR. Install one sign spaced approximately every 7 m (23 feet) on Protection Zone fencing, but no fewer than four signs with each facing a different direction. For essentially straight runs of fencing, signs may be placed 15 m (50-feet) apart, or slightly greater if approved by Project Director/COR.

C. Maintain Protection Zones free of weeds and trash.

D. Maintain Protection Zone fencing and signage in good condition as acceptable to Project Director and remove when construction operations are complete, and equipment has been removed from the site.

1. Do not remove Protection Zone fencing, even temporarily, to allow deliveries or equipment access through the Protection Zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by Project Arborist. Maintain root buffer so long as access is permitted.

3.4 ROOT PROTECTION

A. General: Root protection is intended to reduce compaction, rutting, and contamination of soils and root systems for specimen trees of high impact designated to remain should staging, temporary stockpile, or equipment access be required within tree- and plant-protection areas due to extreme site constraints.

B. Root Zone Protection: Trees anticipated to experience temporary or repetitive materials staging, foot traffic, or equipment access within protected root zone must receive Root Protection Matting (RPM) or Root Aeration Matting (RAM), as applicable. For high impact trees, the Project Arborist will determine need to place wood chip mulch of 50- to 100-mm (2- to 4-inch) thickness under matting.

C. All-Weather RPMs: Where all-weather usage requires special protection against heavy vehicle use, provide 300-mm (12-inch) stone layer over RPM to allow these vehicles to have potential for dynamic compaction without rutting original surface soils and roots. This additional stone layer may be contained with silt fence or super silt fence where adjacent to or within tree-protection zone.

D. Protection Fencing at RPMs and RAMs: Since these mats are intended for greater than 24 hours, surround matted area with protection fencing in accordance with this Section.

1. For temporary staging of soils only, “trenchless” silt fence fabric may be installed; locate on lower/downhill side or as directed by Project Arborist.

E. Short-Duration Staging Mats: If access and operations are needed for 24 hours or less, use approved temporary mat products such as “Alturnamats”, 19-mm plywood sheathing, 25-mm steel plate or similar material as approved by Project Director/COR to avoid rutting and compaction. These products or materials may be shifted and reused as work progresses as long as they maintain suitable strength.

3.5 [EXCAVATION

A. General: Excavate at edge of Protection Zones and for trenches indicated within Protection Zones according to requirements in Section 312000 "Earth Moving" unless otherwise indicated.

B. Trenching within Protection Zones: Where utility trenches are required within Protection Zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.

C. [Where identified on the Drawings, redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 75 mm (3 inches) back from new construction and as required for root pruning.]

D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.]

3.6 TREE REMOVAL

A. Trees indicated on Drawings to be removed, or otherwise identified by Project Arborist for removal, must be removed to point at least 300-mm (12-inches) below lowest level of sub-grade upon which topsoil fill will be placed.

1. Backfilling with ground tree stump material is not permitted.
2. Adjacent Paved Areas: Areas within radius of 3 meters (10 feet) of removed trees that are under areas to be paved must receive treatment as recommended by Civil Engineer prior to preparation of sub-grade for the paved area.

B. Project Arborist must identify those trees that are indicated to remain on the Drawings but are dead trees or are damaged to the point of being incapable of restoration to normal growth pattern lifespan. These trees must be removed at the expense of the Contractor. Project Arborist must notify Project Director/COR within 48 hours.

3.7 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends**.**
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune tree roots 300 mm **(**12 inches**)** outside] of the Protection Zone by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zones: Clear and excavate by hand to the depth of the required excavation to minimize damage to tree root systems. Use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.8 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches as directed by Project Arborist, or otherwise as follows:

1. Prune to remove only [**injured,**] broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
3. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:

   a. Type of Pruning: Cleaning, raising, reducing, and thinning where indicated.
   b. Specialty Pruning: Restoration, vista, and utility where indicated.

B. Cut branches with sharp pruning instruments; do not break or chop.

C. Do not paint or apply sealants to wounds.

D. Provide subsequent maintenance pruning during Contract period as recommended by Project Arborist.

E. Chip removed branches and dispose of off-site**.**

3.9 REGRADING

A. Coordinate with Section 312507 “Temporary Erosion and Sedimentation Controls.” Provide coordinated measures to control erosion due to activities outside of Protection Zones.

B. Lowering or Raising Grade within Tree Protection Zones: No modifications to existing grade must be made within Protection Zones.

C. Lowering Grade at Edge of Protection Zones: Where new finish grade is indicated below existing grade of Protection Zones, begin to adjust slope 1 meter (3 feet) away from Protection Zone fencing.

D. Raising Grade at Edge of Protection Zones: Where new finish grade is indicated above existing grade of Protection Zones, provide drainage away from Protection Zones as indicated, or at minimum 1 meter (3 feet) from protection-zone fencing.

E. Minor Fill within Protection Zone: Where existing grade is 50 mm (2 inches) or less below elevation of finish grade, and if directed by Project Arborist, fill with backfill soil; place backfill soil in a single uncompacted layer, and hand grade to required finish elevations.

3.10 FIELD QUALITY CONTROL

A. Inspections: Project Arborist must direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain, and must prepare inspection reports. Inspections must include, but are not limited to, the following:

1. Weekly Inspections: The Project Arborist must perform weekly inspections to monitor changing conditions and tree health and submit a written report to the Project Director/COR.
2. Wall Construction and Pavements: The Project Arborist must perform inspection during wall, utility, and pavement construction.
3. Special Activities within the Tree-Protection Zone: Work within the Tree-Protection Zone requires the direct on-site supervision of the Project Arborist. The Project Arborist must provide a field report for each visit recording the activities performed and the precautions implemented.

3.11 SOIL AERATION

A. Soil Aeration: Where directed by Project Arborist, aerate surface soil compacted during construction. Aerate 3 m (10 feet) beyond tree drip line and no closer than 900 mm (36 inches) to tree trunk. Drill 50-mm- (2-inch-) diameter holes a minimum of 300 mm (12 inches) deep at 600 mm (24 inches) on center. Backfill holes with an equal mix of augered soil and sand.

3.12 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Government's property

END OF SECTION 311305

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for [**floor slabs**] [**walks**] [**pavements**] [**turf and grasses**] [**and**] [**plants**].
3. Excavating and backfilling for buildings and structures.
4. Drainage course for floor slabs.
5. Subbase course for concrete [**walks**] and [**pavements**].
6. Subbase course [**and base course**] for asphalt paving.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
3. Section 316329 "Drilled Concrete Piers and Shafts" for excavation of shafts and disposal of surplus excavated material.
4. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
5. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subgrade and pavements or walks.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab that also minimizes upward capillary flow of pore water.

F. Filter Material: Drainage fill material to be used in subsurface drainage applications for site retaining walls and building foundations.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Project Director/COR. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Bulk Excavation: Excavation more than 3 m in width and more than 9 m in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Project Director/COR. Unauthorized excavation, as well as remedial work directed by Project Director/COR, must be without additional compensation.

H. Fill: Soil materials used to raise existing grades.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 0.76 cu. m for bulk excavation or 0.57 cu. m for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 1065-mm maximum-width, short-tip-radius rock bucket; rated at not less than 103-kW flywheel power with bucket-curling force of not less than 128 kN and stick-crowd force of not less than 82 kN with extra-long reach boom.
2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 172-kW flywheel power and developing a minimum of 213.3-kN breakout force with a general-purpose bare bucket.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below base, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct pre-excavation conference at [**Project site**] <**Insert location**>.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.
f. <**Insert agenda items**>.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Geofoam.
4. Warning tapes.
5. Vapor barrier.
6. Drainage material.
7. Waterproofing.

B. Qualification Data: For qualified testing agency.

C. Material Test Reports: For each [**on-site**] [**and**] [**borrow**] soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to [**ASTM D698**] [**ASTM D1557**].
3. California Bearing Ratio (CBR) according to ASTM D 1883 of each soil material proposed to support pavement sections.
4. Corrosion testing (pH, resistivity, sulfate content, and chloride content) to demonstrate that imported soils are not more corrosive to buried concrete or steel than the on-site soils or the corrosion protection measures can accommodate. Corrosion testing of at least four representative samples of each import fill material must include:

a. pH according to ASTM G51
b. Soil resistivity according to American Association of State Highway Officials (AASHTO) T288
c. Water-soluble chloride ion content in soil according to AASHTO T291

d. Water-soluble sulfate content in soil (Method A – Gravimetric) according to AASHTO T290.

5. For each proposed borrow source of fill or backfill, at least four representative samples must be tested for [**total petroleum hydrocarbons (TPH)-gasoline range organics (GRO);] [TPH-diesel range organics (DRO);] [benzene, toluene, ethylbenzene, xylenes (BTEX);] [and] [the EPA hazardous waste profile parameters (EOX, TCLP metals, ignitability, reactivity, polychlorinated biphenyls (PCBs) and paint filter test)]**.

D. Blasting plan [**approved by Project Director/COR and authorities having jurisdiction**].

E. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

F. Health and Safety Plan

1.5 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

B. Geotechnical Testing Agency Qualifications: A qualified independent testing agency approved by the Geotechnical Engineer of Record and Project Director/COR to conduct soil materials testing, as documented according to ASTM D3740 and ASTM E329.

C. Conform to grading, excavation, and other earth moving requirements of the OBO Zoning Code.

D. Pre-Excavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section, "Contractor’s Quality Control” and Section 1.3.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Project Director/COR and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Project Director/COR or authorities having jurisdiction.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted in writing by Project Director//COR and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Project Director//COR not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Project Director/COR's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in [**Section 015000 "Temporary Facilities and Controls"**] [**and**] [**Section 311000 "Site Clearing"**] are in place.

D. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

H. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

I. Demolish and completely remove existing shallow foundation, floor slabs, grade beams, and utilities below all pavement, floor slab, foundations, pile caps, or other structural elements. Replace with satisfactory soil.

J. Refer to the Geotechnical Engineering Report prepared and associated boring and test data for information pertaining to the general subsurface conditions within the project site.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 or a combination of these groups; free of rock or gravel larger than 75 mm in any dimension, debris, waste, frozen materials, vegetation, potentially corrosive materials, and other deleterious matter. These materials should exhibit a Liquid Limit and Plasticity Index of less than 40 and 15, respectively.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction and potentially corrosive imported soils.

D. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 100 percent passing a 50 mm sieve, 80 to 95 percent passing the 25 mm sieve, 50 to 70 percent passing the 9.5 mm sieve, 9 to 20 percent passing the 0.425 mm sieve, and not more than 8 percent passing a 0.075 mm sieve.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 37.5-mm sieve and not more than 12 percent passing a 0.075-mm sieve.

F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 25-mm sieve and not more than 8 percent passing a 0.075-mm sieve.

G. Drainage Course: Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5-mm sieve and zero to 5 percent passing a 2.36-mm sieve.

H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 25-mm sieve and zero to 5 percent passing a 4.75-mm sieve.

I. Sand: ASTM C33/C33M; fine aggregate.

J. Impervious Fill: Soil classification groups CH, MH, CL, ML according to ASTM D 2487 or a combination of these groups.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: As follows:

   a. Grab Tensile Strength: 700 N; ASTM D4632.
   b. Sewn Seam Strength: 630 N; ASTM D4632.
   c. Tear Strength: 250 N; ASTM D4533.
   d. Puncture Strength: 250 N; ASTM D4833.

2. Apparent Opening Size: [**0.425-mm**] [**0.250-mm**] [**0.212-mm**] sieve, maximum; ASTM D4751.
3. Permittivity: [**0.5**] [**0.2**] [**0.1**] per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: As follows:

   a. Grab Tensile Strength: 1100 N; ASTM D4632.
   b. Sewn Seam Strength: 990 N; ASTM D4632.
   c. Tear Strength: 400 N; ASTM D4533.
   d. Puncture Strength: 400 N; ASTM D4833.

2. Apparent Opening Size: 0.250-mm sieve, maximum; ASTM D4751.
3. Permittivity: 0.02 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting [**, low-density**], flowable concrete material produced from the following:

1. Portland Cement: ASTM C150/C150M, [**Type I**] [**Type II**] [**or**] [**Type III**].
2. Fly Ash: ASTM C618, Class C or F.
3. Normal-Weight Aggregate: ASTM C33/C33M, [**19-mm**] [**10-mm**] <**Insert dimension**> nominal maximum aggregate size.

4. Foaming Agent: ASTM C869/C869M.
5. Water: ASTM C94/C94M.

6. Air-Entraining Admixture: ASTM C260/C260M.

B. Produce conventional-weight, controlled low-strength material with 550-kPa compressive strength when tested according to ASTM C495/C495M.

2.4 DRAINAGE PANEL

A. Drainage Panel: MiraDRAIN 6000, Hydroduct 220 with Hydroduct Coil 600 Drainage Composite, or approved equivalent consisting of a 3-dimensional dimpled core and geotextile fabric for use over waterproofing membranes, lagging and retaining wall applications.

2.5 VAPOR BARRIER

A. Vapor Barrier: Multi-ply lamination consisting of highly puncture resistant virgin polyolefin designed for preventing moisture migration through concrete slabs-on-grade with a minimum thickness of 10 mils.

2.6 GEOFOAM

A. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV, 25-kg/cu. m density, 173-kPa compressive strength**] [**Type X, 21-kg/cu. m density, 104-kPa compressive strength**] [**Type VI, 29-kg/cu. m density, 276-kPa compressive strength**] [**Type VII, 35-kg/cu. m density, 414-kPa compressive strength**] [**Type V, 48-kg/cu. m density, 690-kPa compressive strength**].

B. Molded-Polystyrene Board Insulation: ASTM C578, [**Type I, 15-kg/cu. m density, 69-kPa compressive strength**] [**Type VIII, 18-kg/cu. m density, 90-kPa compressive strength**] [**Type II, 22-kg/cu. m density, 104-kPa compressive strength**].

1. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.

C. Connectors: [**Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors**] [**Deformed steel reinforcing bars, 19 mm in diameter**] <**Insert requirement**>.

2.7 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 150 mm wide and 0.1 mm thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 150 mm wide and 0.1 mm thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 750 mm deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface within [x] feet beyond the limit of construction area as specified in Division 31 Section "Site Clearing."

C. After stripping and prior to placing fill, proof-roll subgrade below **[the building slabs], [new fill], [foundations], [and] [pavements**] with a heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding not encountered in the test borings.

D. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.

E. Stockpile on-site materials anticipated for re-use after screening. Care must be taken to avoid blending with the deleterious materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system as indicated in Division 31 Section "Dewatering" as required to keep subgrades dry and convey groundwater away from excavations. Groundwater levels should be maintained a minimum of 0.6m (2 ft) below subgrade level. Maintain until dewatering is no longer required.

D. Dispose of all dewatering effluent in strict accordance with the project environmental requirements, US Federal regulations, and local requirements. The Project Director must review and approve dewatering disposal method.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

B. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

1. Perform blasting without damaging adjacent structures, property, or site improvements.
2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 600 mm outside of concrete forms other than at footings.
b. 300 mm outside of concrete forms at footings.
c. 150 mm outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 150 mm beneath bottom of concrete slabs-on-grade.
f. 150 mm beneath pipe in trenches and the greater of 600 mm wider than pipe or 1065 mm wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

a. Foundations must be constructed on suitable natural soils, new compacted fill, or lean concrete. Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
b. Foundation subgrades must be observed by a qualified local Geotechnical Engineer to evaluate whether the soils are suitable for the recommended bearing pressures and to verify that subgrades have not become excessively disturbed.

2. Pile Foundations: Stop excavations 150 to 300 mm above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 25 mm. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades. Excavate to planned subgrade level and remove existing fill, high plasticity, soft/loose soils, and soils containing deleterious materials to a depth of 600 mm or entirely, whichever is less, and replace with compacted satisfactory soil exhibiting a CBR value of at least 6.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
2. See Drawings for duck bank earthwork requirements.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 300 mm higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 300 mm each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 150 mm in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

2. For pipes and conduit 150 mm or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 150 mm deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.8 SUBGRADE INSPECTION

A. Notify Project Director and Geotechnical Testing Agency when excavations have reached required subgrade.

B. If Project Director or Geotechnical Testing Agency determine that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below **[the building slabs], [new fill], [foundations], [and] [pavements**] with a heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction**,** repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 5 km/h.
2. Proof-roll with a loaded dump truck or other suitable weight rubber-tired construction equipment weighing not less than 14 tons. Alternate equipment must be approved by Project Director.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Project Director and Geotechnical Testing Agency, and replace with compacted backfill or fill as directed.

D. In confined areas where proof-rolling with heavy pneumatic-tired equipment is not feasible, the subgrade should be evaluated using other methods to determine the suitability of subgrade soils before fill placement. Other methods include the use of a dynamic cone penetrometer (DCP), geostick penetrometer or similar methods.

E. Subgrades beneath structural slab areas must be sufficient strength to support construction activities and machinery without excessive damage.

F. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

G. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Geotechnical Testing Agency and Project Director/COR, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 17.2 MPa, may be used when approved by the Project Director/COR when foundations bear on soil.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Project Director/COR or Geotechnical Testing Agency.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to protect from rain and to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
2. Contractor must be solely responsible for the stability of stockpiles and the areas where stockpiles are placed. Contractor must stockpile materials in a manner so as to not compromise the stability or cause loss of support to existing structures and surfaces.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, vapor barrier installation, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of debris, water, mud, frost, snow, or ice that are not loose or contain deleterious materials.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 450 mm of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section “Cast-in-Place Concrete.”

D. Trenches under Roadways: Provide 100-mm thick, concrete-base slab support for piping or conduit less than 750 mm below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 100 mm of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section “Cast-in-Place Concrete.”

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 25 mm in any dimension, to a height of 300 mm over the pipe or conduit.

   a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 300 mm over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 300 mm below finished grade, except 150 mm below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil or engineered fill material.

3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

B. Place soil fill on subgrades free of mud, water, frost, snow, or ice and that are not loose or contain deleterious materials.

3.14 GEOFOAM FILL

A. Place a leveling course of sand, 50 mm thick, over subgrade. Finish leveling course to a tolerance of 13 mm when tested with a 3-m straightedge.

1. Place leveling course on subgrades free of mud, water, frost, snow, or ice and that are not loose or contain deleterious materials.

B. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.

C. Install geofoam connectors at each layer of geofoam to resist horizontal displacement according to geofoam manufacturer's written instructions.

D. Cover geofoam with [**subdrainage**] [**separation**] geotextile before placing overlying soil materials.

3.15 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, contain frost or ice or that are loose or contain deleterious materials.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 200 mm in loose depth for material compacted by heavy compaction equipment and not more than 100 mm in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to [**ASTM D698**] [**ASTM D1557**]:

1. Under structures, building slabs, steps, and pavements, compact each layer of backfill or fill soil material at **[95]** percent.
2. Under walkways, compact each layer of backfill or fill soil material at **[95]** percent.
3. Under turf or unpaved areas, compact each layer of backfill or fill soil material at **[92]** percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 25 mm.
2. Walks: Plus or minus 25 mm.
3. Pavements: Plus or minus 13 mm.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 13 mm when tested with a 3-m straightedge.

3.18 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 150-mm course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 300 mm of filter material, placed in compacted layers 150 mm thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 150 mm.

1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 300 mm of final subgrade, in compacted layers 150 mm thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 150 mm.

1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 150-mm thick compacted layers to final subgrade.

3.19 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, water, frost, snow, ice and that are not loose or contain deleterious materials.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 150 mm or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 150 mm in compacted thickness in layers of equal thickness, with no compacted layer more than 150 mm thick or less than 75 mm thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to [**ASTM D698**] [**ASTM D1557**].

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 300 mm wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to [**ASTM D698**] [**ASTM D1557**].

3.20 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Place drainage course 150 mm or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 150 mm in compacted thickness in layers of equal thickness, with no compacted layer more than 150 mm thick or less than 75 mm thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to [**ASTM D698**] [**ASTM D1557**].

3.21 FIELD QUALITY CONTROL

A. Geotechnical Testing Agency: The Contractor will engage a qualified geotechnical engineering testing agency to perform field quality-control testing. Geotechnical Testing Agency must be from independent from Contractor and Contractor's firm unless approved by the Project Director/COR.

B. Allow geotechnical testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2922, ASTM D2937, and ASTM D6938, as applicable. Note that if Contractor request approval to use a electromagnetic density gauge (EDG) according to ASTM D 7830 to assess soil compaction, prior approval should be received from Project Director/COR and a minimum of one sand cone (ASTM D 1556) or drive-cylinder (ASTM D 2937) compaction test must be performed for every 20 EDG tests. Tests will be performed at the following locations and frequencies:

1. Paved and Building Footprint Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 186 sq. m or less of paved area or building footprint but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 30 m or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 46 m or less of trench length but no fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.22 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Project Director/COR; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Government's property.

END OF SECTION 312000

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes construction dewatering.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**> and include the following agenda items:

1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
3. Review geotechnical report.
4. Review proposed site clearing and excavations.
5. Review existing utilities and subsurface conditions.
6. Review observation and monitoring of dewatering system.

1.3 SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

B. Qualification Data: For [**Installer**] [**land surveyor**] [**and**] [**professional engineer**].

C. Field quality-control reports.

D. Existing Conditions: Using [**photographs**] [**or**] [**video recordings**], show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

E. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in [**design of dewatering systems and]** dewatering work.

1.5 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. OBO is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
2. The geotechnical report is [**included**] [**referenced**] elsewhere in Project Documents.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

B. Regulatory Requirements: Comply with governing notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Project Director/COR and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in [**Section 015000 "Temporary Facilities and Controls,"**] [**Section 311000 "Site Clearing,"**] during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed, and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of 600 mm <**Insert dimension**> below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 900 mm below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**] [**monthly**] <**Insert time period**> during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Project Director/COR if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

SECTION 312507 – TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temporary preventative measures for erosion and sedimentation control and for stormwater pollution necessary to protect adjacent properties and municipal water sources from damage due to water erosion, flooding, or deposition of mud or debris originating from work on the site.

B. Related Requirements:

1. Section 311005 "Site Clearing" for general preparation of the site.
2. [Section 311305 "Temporary Tree and Plant Protection".]

1.2 CONTRACTUAL AND REGULATORY AUTHORIZATION

A. Prior to proceeding with site work which may generate erosion, sedimentation damage, and stormwater pollution to the site, adjacent properties, and must obtain authorization to proceed with site work. Required authorization includes:

1. Project Director/Contracting Officer contractual authorization.
2. As applicable, regulatory permits from local or host country authorities.

1.3 ACTION SUBMITTALS

A. Notice of Intent (NOI): Site work authorization request to Project Director/COR. Where required by local or host country authorities, submit their comparable application to local or host country authorities with copy to Project Director/COR.

1. Include Stormwater Pollution Prevention Plan (SWPPP), or comparable plan where required by local or host country authorities.

B. Local or Host Country permit/authorization where applicable.

1. Submit copy of their applicable standard and project-specific regulations and requirements.

C. Qualifications.

1. Responsible individual.
2. Inspector.

D. Notice of Termination (NOT), or comparable documentation used by local or host country authorities.

1.4 QUALITY ASSURANCE

A. Qualifications for Responsible Person and for Inspector: May be same individual. Person(s) knowledgeable in principles and practice of erosion and sediment controls and pollution prevention, and with appropriate skills and training to assess conditions at construction site that could impact stormwater quality, to assess effectiveness of stormwater controls selected, and to ensure requirements of this Section are fulfilled. Minimum three projects performing this role for project of general similar magnitude.

B. Pre-Execution Meeting: On-Site minimum of three weeks in advance of project work protected by this Section.

C. Training: Prior to commencement of activities, Responsible Individual must provide 6-hour training session. Attendees must include:

1. Contractor/subcontractor personnel responsible for work affecting erosion, generation of sedimentation, and generation of stormwater pollution.
2. Inspector of erosion and sedimentation controls, if different than Responsible Individual.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS FOR TEMPORARY CONTROLS

A. In accordance with approved project Stormwater Pollution Prevention Plan (SWPPP).

PART 3 - EXECUTION

3.1 PREPARATION

A. Do not proceed until Notice of Intent (NOI) has been submitted and approved for contractual and regulatory authorization.

3.2 TEMPORARY PROTECTION INSTALLATION

A. Required protection must be in accordance with approved Stormwater Pollution Protection Plan (SWPPP).

1. Protection practices included in SWPPP must be consistent or comparable to those in the U.S. Environmental Protection Agency (EPA) SWPPP template, and in no case be lesser than the following:

    a. Protect newly graded areas from traffic, erosion, and settlements that may occur after clearing, installation of erosion control measures, stockpiling, or excavation until hydroseeding and planting for permanent erosion control is installed, or until otherwise scheduled.
    b. Repair or reestablish damaged grades, elevations, or slopes.
    c. Protect exposed earth surfaces with slope of 2:1 or steeper from inclement weather using hydroseeding or approved polyethylene sheeting staked to ground. Overlay individual polyethylene sheeting minimum of 450 mm (18 inches) at adjacent sheets.
    d. Protect exposed earth surfaces with slopes flatter than 2:1 with straw mulch spread over areas where concentrated surface water is anticipated.
    e. Where work has permanently or temporarily ceased, initiate and complete stabilization measures within time frames outlined in EPA Construction General Permit (CGP) template.

B. Maintenance of Erosion and Sediment Control Measures:

1. For duration of contract, maintain, repair, and replace erosion and sediment control elements where necessary to ensure that system is in good working condition.
2. Inspect erosion control elements in accordance with EPA CGP, and repair as necessary to conform to detail requirements. Corrective actions must be implemented within timeframes identified in EPA CGP.
3. Construct additional control elements at no additional cost where necessary to accommodate Contractor operations or scheduling of work.

3.3 TERMINATION OF TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Ensure final stabilization of all soil.

B. Ensure removal of all sources of water source pollution.

C. Remove products and materials used only for the purpose of providing temporary controls, and surplus materials (e.g., gravel) used for temporary controls. Legally dispose of them off Government's property.

D. Submit Notice of Termination (NOT) to Project Director/COR. Where required by local or host country authorities, submit their comparable application to local or host country authorities with copy to Project Director/COR.

E. Once temporary protections are removed, no further discharge into water sources is permitted.

END OF SECTION 312507

SECTION 313117 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following for termite control:

1. Soil treatment

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site with Project Director/COR present.

B. Notify Project Director/COR at least two weeks in advance of application of termite treatment so that Project Director/COR can contact OBO/OPS/SHEM for input regarding the conference.

C. Conference Topics:

1. Requirements of local Authorities Having Jurisdiction where more stringent than manufacturer's instructions.
2. Manufacturer's application instructions, and interface with Project work.
3. Manufacturer's safety procedures.
4. Include in the conference an anticipated schedule for application of termite treatment to facilitate opportunity of Project Director/COR to observe a portion of the application.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. As applicable, data is used by Government to evaluate whether termiticides are suitably equivalent to EPA-registered termiticides identified in PART 2 PRODUCTS.

1. Include registered label for soil and wood treatment termiticide products; see Article on QUALITY ASSURANCE.
2. Include documentation regarding local or national authorities and regulations.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of termite control product, signed by product manufacturer.

B. Qualification Data: For qualified Installer.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Government's record information, including the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Brand name and manufacturer of termiticide.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes, and rates of application used.
6. Areas of application.
7. Water source for application.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A Pest Management Professional (PMP) who is licensed according to regulations of local authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located, who has at least five years of experience with termite control, who has completed termite control treatment similar to that specified for this Project, and whose work has a record of successful in-service performance.

B. Regulatory Requirements: Formulate and apply termiticides to comply with U.S. Environmental Protection Agency (EPA) regulations, or with local authorities having jurisdiction and acceptable to the Department, as applicable.

1. Document any applicable local codes or local or national authorities, and local or national regulations or codes, to facilitate compliance.
2. Label with a EPA registration number or similar label used by local authorities having jurisdiction if applicable.

C. Implement applicable provisions of the Quality Control program as established in Division 01 Section "Contractor’s Quality Control."

1.6 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with restrictions identified in EPA-Registered Label or by local authorities having jurisdiction, as applicable.

1.7 COORDINATION

A. Coordinate soil treatment application with excavating, filling, and grading and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs, before construction

PART 2 - PRODUCTS

2.1 TERMITICIDES

A. Soil Termiticide: Provide a termiticide in an aqueous solution formulated to prevent termite infestation.

1. The Department of State currently only authorizes fipronil and imidacloprid as soil termiticides. The following are the only EPA-registered soil termiticide formulations acceptable to the Department:

   a. BASF Corp., Agricultural Products: Termidor.
   b. Bayer Environmental Science: Premise.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control.

1. Examine for compliance with requirements for moisture content of the soil per termiticide label.
2. Examine for general removal of cleared vegetation, of wood and cellulose construction debris (including form boards and grade stakes).
3. Examine for minimum clearance of 150 mm of unsupported finishes and wood above finished grade.
4. Examine for grading and roof drainage at foundations; finish grade should slope away from buildings, and roof drainage should not be directed onto grade (i.e., it should be connected to piped stormwater drainage system).
5. Examine for clearance of trees with potential to grow at least 12 meters in height; these should be placed at least 15 meters from foundations.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare work areas in accordance with the most stringent requirements of either local authorities having jurisdiction or manufacturer's written instructions before begging application of termite control treatments. Remove extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of local authorities having jurisdiction and Project Director/COR.

C. Coordinate preinstallation conference with Project Director/COR.

3.3 APPLICATION STANDARDS

A. Comply with the most stringent application requirements of local authorities having jurisdiction, manufacturer's EPA-Registered Label for products, or requirements of this Section.

3.4 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute the treatment evenly. Apply treatment at the label volume and rate for maximum specified concentration of termiticide, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed; often a slab will crack or shrink away from the foundation wall allowing termites to infest the wood above.

a. Apply termiticide after installation of the sub-slab fill material.
b. Apply diluted insecticide to the fill material in accordance with the label (typical rate is 4.0 L/m^2 (1 gal. per 10-sq. ft)).
c. If final fill material is washed stone, apply termiticide in accordance with the label, (typical rate of 6.0 L/m^2 (1½ gal. per 10 sq. ft)).
d. Establish vertical barrier around foundation elements adjacent to slabs.

2. Foundations:

a. Establish continuous termiticide barrier in soil adjacent to foundation elements.
b. Apply treatment after the footings have been poured and the foundation walls and /or pillars have been built. The soil
c. Apply termiticide in soil by trenching or trenching and rodding adjacent to foundation elements.
d. For shallow footings, remove soil trenching, and treat with termiticide as soil is being replaced into trench.
e. Where footings are exposed, perform treatment next to footing but not below bottom of footing.
f. Where deep footings exist (such as basement), apply termiticide as soil backfill is being placed around foundation. Alternatively, trench and rod into trench, or trench

along foundation walls and around pillars and other foundation elements, and apply termiticide at rate prescribed by label from top of grade to minimum depth of 1.20 m (4 feet).

g. Apply termiticide on all sides of all foundation elements, including chimney bases, foundation walls, pilasters, and pillars.

h. French drains and other foundation drainage systems present a hazard of contamination outside treatment zone. Perform treatment in a manner that will not introduce insecticide into drainage system.

i. Apply termiticide to minimum depth of 1.20 m (4 feet) at the rate of 5 L per meter, per each 30 cm of depth (4 gallons per 10 linear feet, per foot of depth) to adjacent soil (including soil along entire inside perimeter of foundation walls):

1) Along both sides of interior partition walls.
2) Around plumbing pipes and electric conduit penetrating slab.
3) Around interior column footers, piers, and chimney bases.
4) Along entire outside perimeter, from grade to bottom of footing.

j. Avoid soil washout around footings.

3. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

4. [Masonry: Treat voids.]

B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

D. Post warning signs in areas of application.

E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313117

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**> and include the following agenda items:

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system specific project needs.

B. Design Criteria:

1. Design support of excavation in accordance with design criteria as specified in the Contract and on the Construction Documents.
2. Design component members of the excavation support system to support maximum loads occurring during excavation or removal stages.
3. Design excavation support to limit wall lateral deformations to **[XX]** percent of the exposed wall height at any given stage. Design excavation support to limit ground settlements to **[XX]** mm.
4. Support of excavation walls should be designed to ensure stability against passive failure of the embedded portion of the vertical wall elements (below the case of the excavation). The minimum factor of safety should be **[XX]** .
5. Where anchors are used, the axial load carrying capacity of the embedded portion of the vertical wall elements (below the base of the excavation) must be evaluated. The minimum FS must be **[XX]**. The wall must be designed to resist vertical loads including vertical

anchor forces and the weight of the lagging and the vertical wall elements. Relying on transfer of vertical load into the soil behind the wall by friction must not be permitted, unless approved by the Engineer.

6. The external stability of the wall must be evaluated. Failure surfaces extending beyond the ends of the ground anchors and below the bottom of the wall must be checked using slope stability calculations. The minimum FS with respect to external stability must be **[XX]** for the wall system.
7. The external stability of the wall system subjected to the seismic acceleration provided in the Geotechnical Report must be evaluated using slope stability calculations. The minimum FS must be **[XX]**.
8. Where soft underlying layers exist, the basal stability of the wall should be evaluated. The minimum FS must be **[XX]**.
9. The design and testing of anchors must be in accordance with the PTI DC35.1-14 Recommendations.
10. Surcharge vertical load due to adjacent traffic or equipment for design must be **[XX]** kPa unless noted otherwise on the Contract Documents. The Contractor may require and designate additional loading based on the construction equipment to be used. The type, magnitude, and location of this additional loading must be shown on the working drawings, with limitations and restrictions clearly shown.

1.3 SUBMITTALS

A. Delegated-Design Submittal: For excavation support and protection systems, include design drawings and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of structural elements and other components of excavation support and protection system.
3. Indicate type and location of waterproofing.
4. Provide estimates of wall and ground movements at various stages of construction.
5. Include assessments of nearby structures if required in accordance with the OBO Building Code.

B. Work Plan and Method Statement: The Contractor's Qualified Professional Engineer must prepare an outline of the Contractor's construction methods and step-by-step procedures together with plans and details of proposed excavation support and bracing. At a minimum, this work plan must include:

1. Detailed temporary excavation support wall construction sequence.
2. A preliminary construction sequence including a clear plan indicating locations of material storage areas and limits of work areas during different stages of construction.
3. Plan describing how surface water will be diverted, controlled and disposed off-site including wall drainage elements.
4. Proposed methods and equipment for excavation of the soil to the staged excavation lifts.

5. Measures to ensure wall and slope stability during various stages of wall construction and excavation where discontinuous rows of anchors will be installed (if applicable); information on space requirement for installation equipment; temporary shoring plans (if applicable); information on provisions of working in the proximity of underground utilities (if applicable).
6. Drill hole diameters and lengths of verification test and production anchors the Contractor intends to use and any variation of these along the wall alignment in order to achieve the performance requirements.
7. Proposed anchor drilling and grouting method, and equipment required to achieve the installation lengths and pullout resistance values to achieve the performance requirements stated on the Contract Drawings.
8. Proposed anchor testing methods and equipment (if applicable) including but not limited to:

    a. Details of jacking frame and appurtenant bracing. If the jack is to rest on a shotcrete construction facing, the Contractor must submit design calculations showing that no damage to the shotcrete facing will occur during the jacking procedure.
    b. Details showing methods of isolating anchors during shotcrete application (i.e. methods to prevent bonding of the anchor and the shotcrete facing during testing, if tested after shotcreting).
    c. Details showing methods of providing the temporary unbonded length for test anchors and of grouting the temporary unbonded length of after completion of testing.
    d. Certified calibration records of hydraulic jack, pressure gauge and load cell calibrated together as a set, for all such sets the Contractor intends to use. Calibration records must include the date tested, device ID and the calibration test results and must be certified for an accuracy of 2 percent of the applied certification loads or better by a qualified independent testing laboratory within 90 days prior to submittal. If the Contractor decides to use a different combination of the jack, pressure gauge and load cell a new set of calibration results will have to be submitted at least 3 days prior to the intended use of the equipment.

9. Proposed methods and procedures to safeguard against loss of slurry, concrete, or grout into other project areas, storm and sanitary sewers, or off-site.
10. Quality control plan for slurry to include minimum and maximum properties, types of testing, and frequency of testing. Testing must include density, viscosity, pH, and sand content at a minimum.

C. Monitoring Plan: Submit proposed plan to monitor vibrations, accelerations, vertical settlement, and lateral movement of temporary support structures, adjacent ground, and existing structures and infrastructure within the zone of influence of proposed excavations.

1. Include product data for materials used in monitoring activities including product data cut-sheets and calibration data used to identify the allowable tolerances of all proposed equipment. Unless otherwise indicated, transmit all submittals to the Project Director/COR for review before proceeding with ordering, fabricating, or any other work of this Section.
2. Include drawings showing the plan and vertical locations of all proposed monitoring points. The plan must graphically identify the type of monitoring point (i.e., optical survey, surface

points, seismographs, crack gages, borehole instruments, benchmarks, etc.), with each monitoring point bearing a unique identification number. Where required, provide section drawings (i.e., excavation faces, building facades, etc.) and identify the elevations at which monitoring points have been or will be installed. The drawings must be updated and resubmitted in the event that monitoring points are abandoned, relocated, or additional monitoring points are added.

3. The plan should identify Alert and Action levels for vibrations and movements at each monitoring location.

D. Pre-Construction Conditions Survey: The Contractor must perform a pre-construction conditions verification survey and must submit any findings that differ from the Project Director/COR's survey as specified herein at least 15 days before beginning the work.

E. Qualification Data: For the following:

1. Land surveyor.
2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in a U.S. State or Territory.

F. Existing Conditions: Using [**photographs**] [**or**] [**video recordings**], show existing conditions of adjacent buildings, structures, and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

G. Baseline Monitoring Report: The Contractor must submit a baseline data report at the start of construction summarizing the baseline values for each instrument. This must include a summary of baseline value determination and the resultant baseline or datum value to be used for comparison with all subsequent monitoring data. Requirements of the baseline value determination are discussed elsewhere herein.

H. Monitoring Reports: Provide **[daily/weekly]** monitoring reports to the Project Director. Reports should summarize the results of monitoring, exceedances of Alert or Action limits, and any corrective actions that were taken. Maintain the instrumentation and monitor measurements during and after construction up to Project Closeout or when directed by the Project Director to cease.

I. Anchor grout, shotcrete, and other concrete/grout mix design (if applicable) in accordance with 033000

1.4 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support, and protection systems, and other subsurface structural, electrical, or mechanical conditions.

B. Final Monitoring Report: Summarize the results of monitoring and any corrective actions that were taken.

C. Installation logs inclusive of any inconsistent or variable conditions encountered.

D. Field and sample test results including grout, shotcrete, and concrete strength.

E. Tieback test results (if applicable).

1.5 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Project Director/COR no fewer than [**two**] <**Insert number**> days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Project Director/COR written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide suitable piles, sheeting, bracing, lagging underpinning, and support, and temporary tie back anchor materials which will withstand loads imposed without unsatisfactory movement. Materials must be kept in serviceable condition at all times.

B. Materials comprising or used to fabricate the excavation support system must be determined by the Contractor. The Contractor must make use of such methods of work as are best adapted to preserve the safety and stability of foundations, walls, and other parts of existing neighboring buildings and structures.

C. Provide survey targets, survey marks, and seismographs to perform the required monitoring.

PART 3 - EXECUTION

3.1 MONITORING

A. The Project Director/COR may monitor instrumentation at any time. Provide and facilitate access to instrumentation for the Project Director/COR and any other party as requested by the Project Director/COR.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

3.3 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.4 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation.

1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
3. Accurately align exposed faces of flanges to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**] <**Insert tolerances**>.

B. Install wood lagging within flanges of soldier piles as excavation proceeds.

1. Trim excavation as required to install lagging.
2. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.5 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

1. Accurately align exposed faces of sheet piling to vary not more than [**2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment**] <**Insert tolerances**>.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.6 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.8 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.9 FIELD QUALITY CONTROL

A. Contractor Responsibilities:

1. Establish field quality control procedures.
2. Maintain records of field quality control measurements and tests.
3. Provide the following observation and survey data:

   a. Movements monitoring of surrounding structures, pavements, and other features potentially subject to damage due to temporary excavation.
   b. Tieback or soil nail testing.
   c. Installation records for secant pile walls or diaphragm walls to include:

      1) Actual top and bottom elevations
      2) Description of Soil Materials
      3) Description, location, and dimensions of obstructions
      4) Variation of wall from plumb
      5) Levelness of bottom and adequacy of cleanout
      6) Groundwater conditions, depth, and pumping required.
      7) Date and time of starting and completing excavation.
      8) Position of reinforcing steel.
      9) Concrete placing method, including elevation of consolidation and delays.
      10) Actual volume of concrete placed including comparison to theoretical volume.
      11) Concrete testing results
      12) Remarks, unusual conditions encountered, and deviations from requirements.

   d. Photographic survey of existing conditions.

4. Other Items:

   a. Conduct Pre-Condition Surveys as necessary on structures within 200 m from excavation support system to document conditions prior to commencement of pile driving operations. Crack gauges should be installed and monitored weekly on any existing cracks identified within the surrounding structures.
   b. Alert neighboring property owners prior to commencement of pile driving or drilling and support of excavation installation operations to alert them of the perceptible ground vibrations that will be generated.

B. Survey-Work Benchmarks: Resurvey benchmarks [**regularly**] [**daily**] [**weekly**] <**Insert time period**> during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.

2. Promptly notify the Project Director if Alert levels are exceeded or if cracks, sags, or other damage is evident in adjacent construction.

3.10 PROTECTION

A. Protect adjoining properties, streets, and utilities. Repair and restore damage caused by construction operations.

B. The responsibility for any damage to adjacent buildings and associated structures, adjacent utilities, sidewalks, pavement, and other facilities in the vicinity resulting from the Contractor's operations will be entirely his, and he must take whatever measures necessary to prevent the same. Should damage occur due to work of this Section, all costs in connection with the repair of such damage and restoration of damaged construction to its original condition and to the satisfaction of the owner must be borne solely by the Contractor.

C. Provide vibration monitoring during pile driving or drilling, if applicable, to include the following observations and controls:

1. Vibration levels at the structure of concern must be limited to 1.25 cm/s (0.5 inch/s) for existing structures. These limits may be refined during vibration monitoring to establish site specific limits to be used during pile driving.
2. Monitor ground vibrations during pile driving or drilling to obtain a well-defined relationship between peak particle velocity and distance (both horizontal and slant) from the pile being driven or drilled.
3. Use equipment capable of providing a continuous visual reading of particle velocity. The equipment must be equipped with a three-channel recording system to record the three components of particle velocity.

    a. For each pile monitored, submit the following information:

        1) Pile designation and location,
        2) Pile type and dimensions,
        3) Pile hammer,
        4) Horizontal distance from pile,
        5) Record of particle velocity vs. depth,
        6) Plot of peak particle velocity from the pile.

D. The Contractor must establish monitoring points at select locations on adjacent buildings within 30 meters of the work and on the excavation support system to adequately monitor and otherwise keep him informed of the conditions during the work.

1. Monitoring points must be placed at 20 m spacing along the face of the adjacent structures.
2. Monitoring points must be placed along the top of the excavation support and protection system at a maximum spacing of 10 meters.
3. A minimum of four additional monitoring points must be established away from the Site so as to establish initial elevations with distance from the site. Additional monitoring points may be required based on the Contractor's means and methods of survey.

4. Establish and monitor all elevation points to an accuracy of 1 mm. Measure monitoring point elevations at least twice a week during temporary excavation support installation, foundation construction, and until the permanent support is complete. Record and report elevation of each benchmark at least twice a week while installation is in progress. On the same day, submit to the Project Director a written monitoring data report, signed, and sealed by a professional land surveyor.
5. Should adjacent building monitoring point readings indicate a displacement exceeding 3 mm between two consecutive readings or a cumulative displacement exceeding 6.4 mm, halt excavation, sheeting and bracing, and foundation construction until corrective action has been provided by the Contractor and is acceptable to the Project Director. The above threshold criteria are tentative; it must be the Contractor's responsibility to monitor conditions during his work to assure the protection requirements specified herein are maintained.

E. The above described monitoring is the minimum required. The Contractor must establish all necessary monitoring measures as necessary to inform him of the conditions around the site and that his work is not adversely impacting surrounding structures.

3.11 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

2. Remove excavation support and protection systems to a minimum depth of 1200 mm below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

SECTION 316213 - CONCRETE PILES

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Available information for reference as part of the request for proposal and bidding include the following:

1. Plan Set(s) ____, Project No. _____, prepared by _____, dated _____.
2. Geotechnical Report No.(s)_____, Project No. _____, prepared by _____, dated _____, included or referenced in the bid documents, containing the results of exploratory borings, observation pits, or other site investigation data obtained in the vicinity of the proposed timber pile locations.

1.2 SUMMARY

A. Section includes [**hollow**] [**solid**], precast, prestressed concrete piles.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

B. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule activities and identify contractual relationships and delineation of responsibilities among the prime Contractor and various Subcontractors.

1. The Engineer, prime Contractor, concrete pile Contractor, Inspectors, and Geotechnical Instrumentation Specialist (if applicable) must attend the meeting.
2. During preinstallation conference, the attendance should discuss the subsurface conditions, pile installation and testing, quality control and assurance plan, pile structure survey control, site drainage control, review proposed pile driving equipment to be used (such as leads, pile hammers, helmet, pile cushion or any other accessories), to be used, and any other detail that may affect the construction the timber piles.
3. Review methods and procedures related to timber piles including, but not limited to, the following:

   a. Review geotechnical report.
   b. Discuss existing utilities and subsurface conditions.
   c. Review coordination with temporary controls and protections.

d. Review of QA/QC and safety procedures.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For concrete piles. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and lifting devices necessary for handling and driving piles.

1. Indicate pile dimensions, cross sections, locations, and sizes. Show details of pile splices and shoes.
2. Indicate types of reinforcement, including prestressing strand, and detail fabricating, bending, and placing.
3. Indicate layout and dimensions and identify each pile. Indicate welded connections by AWS standard symbols. Detail cast-in hardware.
4. Indicate transportation, storage, and lifting points.

5. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Pile Driving Sequential Layout:

1. Submit layout drawings showing the proposed sequence of pile driving, pile identification as indicated on the Contract Drawings, its driving sequence number, type, size, load bearing capacity and pile tip elevation planned.
2. Pile installation plan
3. Pile Driving

D. Qualification Data: For [**Installer**] [**manufacturer**] [**professional engineer**] [**and**] [**testing agency**].

E. Welding certificates.

F. Design Mixes: For each concrete mix.

G. Material Certificates: For [**steel reinforcements**] [**prestressing strand**] [**and**] [**concrete admixtures**].

H. Material Test Reports: For concrete materials.

I. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

J. Approval of pile driving equipment by the Engineer will be based on wave equation analysis unless a dynamic formula has been specified for nominal resistance verification in the field. In no case must the driving equipment be transported to the project site until approval of the Engineer is received in writing.

K. Static Pile Test Reports: Submit within three days of completing each test.

L. Pile-Driving Records: Submit within three days of driving each pile.

M. Certified Piles Survey: Submit within **[seven] <Insert number>** days of pile driving completion.

N. Field quality-control reports.

O. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Engineering Responsibility: Assumes engineering responsibility to comply with requirements in "Performance Requirements" Article by engaging a qualified professional engineer to prepare design calculations, Shop Drawings, and other structural data for piles.

2. PCI Plant Certification Program: Participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for [**B2**] [**and**] [**C2**] product group and category, or better.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

D. Design Practices: Comply with ACI 318M (ACI 318) and the recommendations in PCI Committee Report: "Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling."

E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for piles, comply with applicable requirements in PCI MNL-116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

F. Comply with requirements in ACI 301, "Specifications for Structural Concrete."

G. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.6 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**1524 mm (60inches)**] <**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test [**and the following Procedures:**][**.**]

a. Procedure B, Maintained Test.
b. Procedure C, Loading in Excess of Maintained Test.
c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Project Director/COR at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**] <**Insert number**> days to elapse after driving test piles before starting pile testing.

2. Number of Test Piles: [**One pile**] [**As indicated**] <**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**] <**Insert load**>.

F. Approval Criteria: Allowable load must be the load acting on the test pile when [**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**] <**Insert value**>:

1. Net settlement, after deducting rebound, of not more than 0.25 mm/907 kg (0.01 inch/ton) of test load.
2. Total settlement exceeds the pile elastic compression by 4 mm (0.15 inch), plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile [**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent cracking, distorting, warping, or other physical damage, and so markings are visible.

B. Lift and support piles only at designated lifting or supporting points as shown on Shop Drawings.

1.8 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**] [**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. [**Comply with Section 013233 "Photographic Documentation."**]

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. <**Insert, in separate subparagraphs, manufacturer's name**>.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design piles, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Piles must withstand transportation, erection, and driving stresses and design loads within limits indicated and under conditions existing at Project site.

1. Design Loads: <**Insert loads**>.

2.3 MOLD MATERIALS

A. Molds: Provide molds of metal, plastic, wood, or another material that is nonreactive with concrete and that produces required finish surfaces.

2.4 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 420 (Grade 60); deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M.

C. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 420 (Grade 60)**] [**ASTM A706/A706M**], deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 420 (Grade 60)**] [**ASTM A706/A706M**], deformed.

E. Plain Steel Wire: ASTM A82/A82M, [**as drawn**] [**galvanized**].

F. Deformed-Steel Wire: ASTM A496/A496M.

G. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**] [**deformed**].

2.5 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A416/A416M, Grade 1725 or 1860 (Grade 250 or 270); uncoated, seven-wire, low-relaxation strand.

2.6 CONCRETE MATERIALS

A. General: Limit water-soluble chloride ions in concrete to the maximum percentage by mass of cementitious material permitted by ACI 318M (ACI 318), but not more than 0.06 percent.

B. Portland Cement: ASTM C150/C150M, [**Type I or Type III**] [**Type II**], of same type, brand, and source.

1. Fly Ash: ASTM C618, Class C or F.
2. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates: Except as modified by PCI MNL-116, ASTM C33/C33M, with coarse aggregates complying with [**Class 4S**] [**Class 4M**] [**Class 1N**] <**Insert class**>. Provide aggregates from single source.

1. Nominal Maximum Size of Aggregate: [**25 mm (1 inch)**] [**19 mm (3/4 inch)**].

D. Water: Potable, free of deleterious material that may affect color stability, setting, or strength of concrete, and complying with chemical limits of PCI MNL-116.

E. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures.

1. Air-Entraining Admixture: ASTM C260/C260M.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.

3. Retarding Admixture: ASTM C494/C494M, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
5. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
7. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
8. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.7 PILE ACCESSORIES

A. Pile Shoes: 25 mm (1 inch) thick minimum, carbon-steel plate fabricated to match shape of pile tip.

B. Pile Splices: Manufactured from carbon-steel plates or castings and capable of developing strength of continuous pile at splice location.

2.8 CONCRETE MIXES

A. Prepare design mixes for each type of concrete required.

1. Limit use of fly ash and silica fume to not exceed, in total, [**25**] <**Insert number**> percent of portland cement by weight.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified personnel at precast manufacturing plant at precast manufacturer's option.

C. Proportion mixes by either laboratory trial batch or field-test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): [**55.2 MPa (8000 psi)**] [**48.3 MPa (7000 psi)**] [**41.4 MPa (6000 psi)**] [**34.5 MPa (5000 psi)**] <**Insert value**>.

2. Maximum Water-Cementitious Material Ratio: 0.40.

D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of [**6.0 percent, plus or minus 1.5**] [**2.5 to 4.5**] percent.

2.9 FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete placement and temperature changes and for pretensioning and detensioning operations. Maintain molds to provide completed piles of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116 and PCI MNL-135.

1. Unless molds are stripped before detensioning, design molds so stresses are not induced in piles due to deformation of concrete under prestress or movement during detensioning.

2. Chamfer edges and corners of square piles.

B. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

1. Accurately position, support, and secure reinforcement against displacement by molds, construction, or concrete placement. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
2. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

C. Prestress tendons for piles by either pretensioning or post-tensioning methods. Comply with PCI MNL-116.

D. Pile Shoes: Accurately position and secure pile shoes at pile tips so as to not affect pile alignment during driving. Weld pile shoes to longitudinal reinforcements.

E. Pile Splices: Accurately position and secure pile-splice segments requiring embedding in tips of piles.

F. Mix concrete according to PCI MNL-116 and requirements in this Section. After initial concrete batching, no additional water may be added.

G. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in piles. Comply with requirements in PCI MNL-116 for measuring, mixing, transporting, and placing concrete.

1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL-116.
2. Comply with ACI 306.1 procedures for cold-weather concrete placement.
3. Comply with ACI 305R recommendations for hot-weather concrete placement.

H. Identify pickup points of piles with permanent markings that correspond with markings indicated on Shop Drawings. Imprint casting date on each pile.

I. Cure concrete, according to requirements in PCI MNL-116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

J. Delay detensioning piles until concrete has attained at least [**70**] <**Insert number**> percent of its compressive strength as established by test cylinders cured under the same conditions as concrete.

1. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

K. Where ends of strands are not enclosed or covered, cut flush and cover with a high-strength mortar bonded to unit with an epoxy-resin bonding agent.

L. Fabricate precast, prestressed concrete piles straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL-116 and PCI MNL-135 product tolerances.

M. Finish: Fabricate concrete piles with normal plant-run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are tolerated. Major or unsightly imperfections, honeycombs, or structural defects are not permitted.

1. Finish unformed surfaces by trowel unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

N. Pile-Length Markings: Mark each pile with horizontal lines at 305 mm (12 inch) intervals; label the distance from pile tip at 1524 mm (60 inch) intervals. Maintain markings on piles until driven.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to evaluate pile manufacturer's quality-control and testing methods.

1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

B. Testing: Test and inspect piles according to PCI MNL-116.

1. Strength of piles will be considered deficient if units fail to comply with requirements.

C. If there is evidence that strength of piles may be deficient or may not comply with PCI MNL-116 requirements, Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42/C42M.

1. A minimum of three representative cores must be taken from piles of suspect strength, from locations directed by Project Director/COR.

2. Cores must be tested, following immersion in water, in a wet condition per ACI 301 if piles are wet under service conditions.
3. Cores must be tested in an air-dry condition per ACI 301 if piles are dry under service conditions.
4. Strength of concrete for each series of three cores must be considered satisfactory if average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.
5. Test results must be reported in writing on same day that tests are performed, with copies to Project Director/COR, Contractor, and pile manufacturer. Test reports must include the following:

   a. Project identification name and number.
   b. Date when tests were performed.
   c. Name of precast concrete manufacturer.
   d. Name of concrete testing agency.
   e. Identification letter, name, and type of pile represented by core tests; design compressive strength; type of break; compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

D. Patching: If core test results are satisfactory and piles comply with requirements, solidly fill core holes with patching mortar and finish to match adjacent pile surfaces.

E. Piles will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 152 to 305 mm (6 to 12 inches) above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. All pile driving equipment should be sized such that the project piles can be driven with reasonable effort to the estimated contract lengths without damage. Approval of pile driving equipment by the Engineer will be based on wave equation analysis unless a dynamic formula has been specified for nominal resistance verification in the field. In no case shall the driving equipment be transported to the project site until approval of the Engineer is received in writing.

B. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

1. Use pile hammer capable of adjustment to deliver reduced impact to maintain tensile stress within 70 percent of yield strength of pile reinforcement.

C. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

D. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated [**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile. If subsurface obstructions, such as boulders or rock layers are encountered, the diameter of the predrilled hole may be increased with Engineers approval to the least dimension adequate for pile installation.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Pile Splices: Splice piles during installation and align pile segments concentrically.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: 102 mm (4 inches) from location indicated after initial driving, and 152 mm (6 inches) after pile driving is completed.
2. Plumb: Maintain 25 mm (1 inch) in 1219 mm (48 inches) from vertical, or a maximum of 102 mm (4 inches), measured when pile is aboveground in leads.
3. Batter Angle: Maximum 25 mm (1 inch) in 1219 mm (48 inches) from required angle, measured when pile is aboveground in leads.

F. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 1830 mm (72 inches).
2. Fill holes left by withdrawn piles as directed by Project Director/COR.

G. Abandon and cut off rejected piles as directed by Project Director/COR. Leave rejected piles in place, and install new piles in locations as directed by Project Director/COR.

H. Cut off tops of driven piles square with pile axis and at elevations indicated.

I. Buildups: Construct buildups to elevations indicated of cast-in-place reinforced concrete with compressive strength not less than [**34.5 MPa (5000 psi)**] <**Insert value**> at 28 days.

J. Pile-Driving Records: Maintain accurate driving records for each pile [**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Date and time of pile driving (start, stop and interruptions).
4. Hammer make, model, ram weight, energy rating, stroke height and operating speed if available.
5. Type of pile and date of casting.
6. Pile location in pile group and designation of pile group.
7. Sequence of driving in pile group.
8. Pile dimensions.
9. Ground elevation.
10. Elevation of tips after driving.
11. Final tip and cutoff elevations of piles after driving pile group.
12. Records of redriving.
13. Elevation of splices.
14. Type, make, model, and rated energy of hammer.
15. Weight and stroke of hammer.
16. Type of pile-driving cap used.
17. Cushion material and thickness.
18. Actual stroke and blow rate of hammer.
19. Pile-driving start and finish times, and total driving time.
20. Time, pile-tip elevation, and reason for interruptions.
21. Number of blows for every 305 mm (12 inches) of penetration, and number of blows per 25 mm (1 inch) for the last 152 mm (6 inches) of driving.
22. Pile deviations from location and plumb.
23. Pre-boring, jetting, or special procedures used.
24. Unusual occurrences during pile driving.
25. Any visual pile damage during or after pile driving.

K. Certified Piles Survey: Engage a [**land surveyor**] [**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Project Director/COR when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**] [**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring must be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**] [**3 percent of**] <**Insert number or percent of**> piles.

2. Low-strain integrity measurement must be performed and reported for each pile.
3. Rapid Load Tests: If required, the nominal resistance must be determined by a rapid load test performed in accordance with the procedures set forth in ASTM D7383.

D. Piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 316213

SECTION 316216 - STEEL PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes driven steel piles.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For steel H piles. Show fabrication and installation details for piles, including details of driving points, splices, and pile caps.

1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

2. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Qualification Data: For [**Installer**] [**professional engineer**] [**and**] [**testing agency**].

D. Welding certificates.

E. Mill Test Reports: For [**steel H piles**] [**steel castings**] [**and**] [**steel plate**], signed by manufacturer.

F. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.

G. Static Pile Test Reports: Submit within three days of completing each test.

H. Pile-Driving Records: Submit within three days of driving each pile.

I. Certified Piles Survey: Submit within [**seven**] <**Insert number**> days of pile driving completion.

J. Field quality-control reports.

K. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**1524 mm (60 inches)**] <**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

   a. Procedure B, Maintained Test.
   b. Procedure C, Loading in Excess of Maintained Test.
   c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Project Director/COR at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**] <**Insert number**> days to elapse after driving test piles before starting pile testing.

2. Number of Test Piles: [**One pile**] [**As indicated**] <**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**] <**Insert load**>.

F. Approval Criteria: Allowable load must be the load acting on the test pile when [**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**] <**Insert value**>:

1. Net settlement, after deducting rebound, of not more than 0.25mm/907kg (0.01inch/ton) of test load.
2. Total settlement exceeds the pile elastic compression by 4 mm (0.15 inch), plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile [**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent buckling or physical damage.

1. Painted Piles: Protect finish and touch up paint damage before driving piles.

1.7 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**] [**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 STEEL H PILES

A. High-Strength, Low-Alloy, Columbium-Vanadium Structural Steel: ASTM A572/A572M, [**Grade 345 (Grade 50)**] [**Grade 415 (Grade 60)**] <**Insert grade**>.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

B. High-Strength, Low-Alloy, Nickel, Copper, Phosphorous Steel H Piles: ASTM A690/A690M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

C. High-Strength, Low-Alloy, Structural Steel: ASTM A588/A588M.

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2.2 PILE ACCESSORIES

A. Driving Points: Manufacturer's standard one-piece driving point, fabricated from steel castings as follows to provide full bearing of web and flange of pile tip:

1. Carbon-Steel Castings: ASTM A27/A27M, [**Grade 450-240 (Grade 65-35), heat treated**] [**or**] [**Grade N1**].
2. High-Strength Steel Castings: ASTM A148/A148M, [**Grade 550-275 (Grade 80-40)**] [**or**] [**Grade 620-415 (Grade 90-60)**].

B. Splice Unit: Manufacturer's standard splice unit, fabricated from two connected steel plates of same material as steel H pile or material of equal strength, shaped to encase web and part of each flange.

2.3 PAINT

A. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, [**black**] [**red**] [**manufacturer's standard color**].

2.4 FABRICATION

A. Fabricate and assemble piles in shop to greatest extent possible.

B. Pile-Length Markings: Mark each pile with horizontal lines at 305 mm (12 inch) intervals; label the distance from pile tip at 1524 mm (60 inch) intervals. Maintain markings on piles until driven.

C. Fabricate full-length piles to eliminate splicing during driving, with ends square.

D. Fabricate full-length piles by splicing lengths of steel H pile together. Accurately mill meeting ends of piles and bevel for welding. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.

1. Splice Units: Notch web of pile, fit splice unit into position, and weld according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
2. Continuously Welded Splices: Splice piles by continuously welding according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

3. Splice piles during fabrication [**or field installation**].

E. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.5 SHOP PAINTING

A. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:

1. Extend painting to a depth of 1524 mm (60 inches) below [**finished grade**] [**low-tide level**] to top of exposed pile.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, spatter, slag, and flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."

C. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than 0.2 mm (8 mils).

1. Apply second coat to provide a dry film thickness of not less than 0.2 mm (8 mils), resulting in a two-coat paint system thickness of not less than 0.4 mm (16 mils).
2. Apply second and third coats with each coat having a dry film thickness of not less than 0.2 mm (8 mils), resulting in a three-coat paint system thickness of not less than 0.6 mm (24 mils).
3. Mark pile lengths after shop painting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 152 to 305 mm (6 to 12 inches) above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated [**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: 102 mm (4 inches) from location indicated after initial driving, and 152 mm (6 inches) after pile driving is completed.
2. Plumb: Maintain 25 mm (1 inch) in 1219 mm (48 inches) from vertical, or a maximum of 102 mm (4 inches), measured when pile is aboveground in leads.

3. Batter Angle: Maximum 25 mm (1 inch) in 1219 mm (48 inches) from required angle, measured when pile is aboveground in leads.

E. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 1830 mm (72 inches).
2. Fill holes left by withdrawn piles as directed by Project Director/COR.

F. Abandon and cut off rejected piles as directed by Project Director/COR. Leave rejected piles in place, and install new piles in locations as directed by Project Director/COR.

G. Cut off tops of driven piles square with pile axis and at elevations indicated.

H. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile location in pile group and designation of pile group.
4. Sequence of driving in pile group.
5. Pile dimensions.
6. Ground elevation.
7. Elevation of tips after driving.
8. Final tip and cutoff elevations of piles after driving pile group.
9. Records of redriving.
10. Elevation of splices.
11. Type, make, model, and rated energy of hammer.
12. Weight and stroke of hammer.
13. Type of pile-driving cap used.
14. Cushion material and thickness.
15. Actual stroke and blow rate of hammer.
16. Pile-driving start and finish times, and total driving time.
17. Time, pile-tip elevation, and reason for interruptions.
18. Number of blows for every 305 mm (12 inches) of penetration, and number of blows per 25 mm (1 inch) for the last 152 mm (6 inches) of driving.
19. Pile deviations from location and plumb.
20. Pre-boring, jetting, or special procedures used.
21. Unusual occurrences during pile driving.

I. Certified Piles Survey: Engage a [**land surveyor**] [**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Project Director/COR when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**] [**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring must be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**] [**3 percent of**] <**Insert number or percent of**> piles.

2. Weld Testing: In addition to visual inspection, welds must be tested and inspected according to AWS D1.1/D1.1M and inspection procedures listed below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

a. Liquid Penetrant Inspection: ASTM E165.
b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Radiographic Inspection: ASTM E94, minimum quality level "2-2T."
d. Ultrasonic Inspection: ASTM E164.

D. Steel H piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 TOUCHUP PAINTING

A. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.

1. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

3.6 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off USG property.

END OF SECTION 316216

SECTION 316219 - TIMBER PILES

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Available information for reference as part of the request for proposal and bidding include the following:

1. Plan Set(s) ____, Project No. _____, prepared by _____, dated _____.

2. Geotechnical Report No.(s)_____, Project No. _____, prepared by _____, dated _____, included or referenced in the bid documents, containing the results of exploratory borings, observation pits, or other site investigation data obtained in the vicinity of the proposed timber pile locations.

1.2 SUMMARY

A. Section includes round timber piles.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

B. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule activities and identify contractual relationships and delineation of responsibilities among the prime Contractor and various Subcontractors

1. The Engineer, prime Contractor, timber pile Contractor, Inspectors, and Geotechnical Instrumentation Specialist (if applicable) shall attend the meeting.
2. During preinstallation conference, the attendance should discuss the subsurface conditions, pile installation and testing, quality control and assurance plan, pile structure survey control, site drainage control, review proposed pile driving equipment to be used (such as leads, pile hammers, helmet, pile cushion or any other accessories), to be used, and any other detail that may affect the construction the timber piles.
3. Review methods and procedures related to timber piles including, but not limited to, the following:

a. Review geotechnical report.

b. Discuss existing utilities and subsurface conditions.
c. Review coordination with temporary controls and protections.
d. Review of QA/QC and safety procedures.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For timber piles. Show fabrication and installation details for piles, including details of driving shoes, tips or boots, and pile butt protection.

1. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Pile Driving Sequential Layout:

1. Submit layout drawings showing the proposed sequence of driving the piles.
2. On the sequential layout, show each pile identification as indicated on the Contract Drawings, its driving sequence number, type, size, load bearing capacity and pile tip elevation planned.

D. Approval of pile driving equipment by the Engineer will be based on wave equation analysis unless a dynamic formula has been specified for nominal resistance verification in the field. In no case shall the driving equipment be transported to the project site until approval of the Engineer is received in writing.

E. Qualification Data: For [**Installer**] [**professional engineer**] [**and**] [**testing agency**].

F. Round timber pile treatment data as follows, including chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material:

1. For each type of preservative-treated timber product, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
2. For waterborne-treated products, include statement that moisture content of treated materials was reduced to levels indicated before shipment to Project site.

G. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and type, size, and properties of hammer cushion.

H. Static Pile Test Reports: Submit within three days of completing each test.

I. Pile-Driving Records: Submit within three days of driving each pile.

J. Certified Piles Survey: Submit within [**seven**] <**Insert number**> days of pile driving completion.

K. Field quality-control reports.

L. Material Certificates: For preservative-treated piles. Indicate type of preservative used and net amount of preservative retained.

M. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

1.6 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**1524 mm (60 inches)**] <**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

   a. Procedure B, Maintained Test.
   b. Procedure C, Loading in Excess of Maintained Test.
   c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Project Director/COR at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

   1. Allow a minimum of [**seven**] <**Insert number**> days to elapse after driving test piles before starting pile testing.

   2. Number of Test Piles: [**One pile**] [**As indicated**] <**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project, and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

   1. Pile Design Load: [**As indicated**] <**Insert load**>.

F. Approval Criteria: Allowable load shall be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**] <**Insert value**>:

   1. Net settlement, after deducting rebound, of not more than 0.25mm/907 kg (0.01 inch/ton) of test load.

2. Total settlement exceeds the pile elastic compression by 4 mm (0.15 inch), plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile [**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent breaks, cuts, abrasions, or other physical damage and as required by AWPA M4.

1. Do not drill holes or drive spikes or nails into pile below cutoff elevation.

1.8 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**] [**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 TIMBER PILES

A. Round Timber Piles: ASTM D25 Standard Specification for Round Timber Piles, unused, clean peeled, one piece from butt to tip; of the following species and size basis:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers**

offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. <**Insert, in separate subparagraphs, manufacturer's name**>.

2. Species: [**Coastal Douglas fir**] [**Southern yellow pine**] <**Insert species**>.

3. Size Basis: [**Butt circumference**] [**Class A**] [**Class B**] [**Tip circumference**] [**203 mm (8 inch) tip and natural taper**].

B. Pressure-treat round timber piles according to AWPA U1 as follows:

1. Service Condition: [**UC4C Ground Contact, Extreme Duty**] [**UC5A Marine Use Northern Waters**] [**UC5B Marine Use Central Waters**] [**UC5C Marine Use Southern Waters**]

2. Treatment: [**Waterborne preservative**] [**Creosote or creosote solution**] [**Oil-borne preservative**] [**Waterborne preservative, creosote or creosote solution, or oil-borne preservative**] [**Waterborne preservative, severe marine borer hazard**] [**Dual treatment consisting of waterborne preservative, followed by creosote or creosote solution**] <**Insert treatment**>.

2.2 PILE ACCESSORIES

A. Driving Shoes: Fabricate from ASTM A1011/A1011M, hot-rolled carbon-steel strip to suit pile-tip diameter, of the following type and thickness, and secure to pile tip so as to not affect pile alignment during driving:

1. Type: [**Flat boot**] [**Arrow point**].
2. Thickness: [**4.8 mm (3/16 inch)**] [**6 mm (1/4 inch)**].

2.3 FABRICATION

A. Pile Tips: Cut and shape pile tips to accept driving shoes. Fit and fasten driving shoes to pile tips according to manufacturer's written instructions.

B. Pile Butt: Trim pile butt and cut perpendicular to longitudinal axis of pile. Chamfer and shape butt to fit tightly to driving cap of hammer.

C. Field-Applied Wood Preservative: Treat field cuts, holes, and other penetrations according to AWPA M4.

1. Coal-tar roofing cement for treating drilled holes or sealing cutoffs shall be free of asbestos.

D. Pile Splices: Splices are not permitted.

E. Pile-Length Markings: Mark each pile with horizontal lines at 305 mm (12 inch) intervals; label the distance from pile tip at 1524 mm (60 inch) intervals. Maintain markings on piles until driven.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 152 to 305 mm (6 to 12 inches) above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

3.3 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated [**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Spudding: Drive spud piles through overlying highly resistant strata or obstructions and withdraw for reuse.

C. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

D. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: 102 mm (4 inches) from location indicated after initial driving, and 152 mm (6 inches) after pile driving is completed.
2. Plumb: Maintain 25 mm (1 inch) in 1219 mm (48 inches) from vertical, or a maximum of 102 mm (4 inches), measured when pile is aboveground in leads.

3. Batter Angle: Maximum 25 mm (1 inch) in 1219 mm (48 inches) from required angle, measured when pile is aboveground in leads.

F. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 1830 mm (72 inches).
2. Fill holes left by withdrawn piles as directed by Project Director/COR.

G. Abandon and cut off rejected piles as directed by Project Director/COR. Leave rejected piles in place and install new piles in locations as directed by Project Director/COR.

H. Cut off butts of driven piles square with pile axis and at elevations indicated.

1. Cover cut-off piling surfaces with [**caps overlapping pile end by minimum 51 mm (2 inches)**] [**minimum three coats of preservative treatment**] according to AWPA M4.

I. Pile-Driving Records: Maintain accurate driving records for each pile[**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Date and time of pile driving (start, stop and interruptions).
4. Hammer make, model, ram weight, energy rating, stroke height and operating speed if available.
5. Pile species.
6. Pile location in pile group and designation of pile group.
7. Sequence of driving in pile group.
8. Pile dimensions.
9. Ground elevation.
10. Elevation of tips after driving.
11. Final tip and cutoff elevations of piles after driving pile group.
12. Records of redriving.
13. Elevation of splices.
14. Type, make, model, and rated energy of hammer.
15. Weight and stroke of hammer.
16. Type of pile-driving cap used.
17. Cushion material and thickness.
18. Actual stroke and blow rate of hammer.
19. Pile-driving start and finish times, and total driving time.
20. Time, pile-tip elevation, and reason for interruptions.
21. Number of blows for every 305 mm (12 inches) of penetration, and number of blows per 25 mm (1 inch) for the last 152 mm (6 inches) of driving.
22. Pile deviations from location and plumb.
23. Pre-boring, jetting, or special procedures used.
24. Unusual occurrences during pile driving.
25. Any visual pile damage during or after pile driving.

J. Certified Piles Survey: Engage a [**land surveyor**] [**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Project Director/COR when deviations from locations exceed allowable tolerances.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**] [**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**] [**3 percent of**] <**Insert number or percent of**> piles.

3.5 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off USG property.

END OF SECTION 316219

SECTION 316223 - COMPOSITE PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete-filled [**steel-shell**] [**steel pipe**] piles.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For composite piles. Show fabrication and installation details for piles, including splices and tip details.

1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
2. Indicate locations, sizes, type, and arrangement of reinforcement.
3. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Qualification Data: For [**Installer**] [**professional engineer**] [**and**] [**testing agency**].

D. Welding certificates.

E. Design Mixes: For each concrete mix. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

F. Material Certificates: For [**steel-shell piles and accessories**] [**steel pipe piles and accessories**] [**steel reinforcement**] [**and**] [**concrete admixtures**].

G. Material Test Reports: For concrete materials.

H. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and type, size, and properties of hammer cushion.

1. Include mandrel type and details.

I. Static Pile Test Reports: Submit within three days of completing each test.

J. Pile-Driving Records: Submit within three days of driving each pile.

K. Certified Piles Survey: Submit within [**seven**] <**Insert number**> days of pile-driving completion.

L. Field quality-control reports.

M. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1. Installer's responsibility includes engaging a qualified professional engineer to prepare pile-driving records.

B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated[**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

C. Comply with requirements in ACI 301, "Specifications for Structural Concrete."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.5 PRECONSTRUCTION TESTING

A. General: Static pile tests are used to verify driving criteria and pile lengths and to confirm allowable load of piles.

1. Furnish test piles [**1524 mm (60 inches)**] <**Insert dimension**> longer than production piles.
2. Determination of actual length of piles is based on results of static pile tests.

B. Pile Tests: Arrange and perform the following pile tests:

1. Axial Compressive Static Load Test: ASTM D1143/D1143M. Procedure A, Quick Test[**and the following Procedures:**][**.**]

a. Procedure B, Maintained Test.
b. Procedure C, Loading in Excess of Maintained Test.
c. Procedure G, Cyclic Loading Test.

2. Axial Tension Static Load Test: ASTM D3689.
3. Lateral Load Test: ASTM D3966.

C. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.

D. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Project Director/COR at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

1. Allow a minimum of [**seven**] <**Insert number**> days to elapse after driving test piles before starting pile testing.

2. Number of Test Piles: [**One pile**] [**As indicated**] <**Insert number**>.

E. Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.

1. Pile Design Load: [**As indicated**] <**Insert load**>.

F. Approval Criteria: Allowable load shall be the load acting on the test pile when[**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**] <**Insert value**>:

1. Net settlement, after deducting rebound, of not more than 0.25 mm/907 kg (0.01 1inch/ton) of test load.
2. Total settlement exceeds the pile elastic compression by 4 mm (0.15 inch), plus 1.0 percent of the tip diagonal dimension.
3. A plunging failure or sharp break in the load settlement curve.

G. Test Pile-Driving Records: Prepare driving records for each test pile [**, compiled and attested to by a qualified professional engineer**]. Include same data as required for driving records of permanent piles.

H. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent physical damage.

1. Painted Piles: Protect finish and touch up damage before driving piles.

1.7 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile driving.

B. Site Information: A geotechnical report has been prepared for this Project and is [**included**] [**referenced**] elsewhere in the Project Manual for information only.

C. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Document conditions that might be misconstrued as damage caused by pile driving. Comply with Section 013233 "Photographic Documentation."

PART 2 - PRODUCTS

2.1 STEEL-SHELL PILES

A. Fluted Pile Shells: Manufacturer's standard, vertically fluted, pile shells; cold formed from steel sheet; 345 MPa (50,000 psi) minimum yield strength after forming. Fabricate watertight, uniformly tapered sections with forged-steel conical nose welded to tip.

1. Constant Diameter Extensions: Fabricate with splice overlap capable of telescoping into tapered section.

2. Taper: [**1:86 (0.14 inch in 12 inches)**] [**1:48 (0.25 inch in 12 inches)**] [**1:30 (0.40 inch in 12 inches)**].

3. Thickness: [**3.80 mm (0.150 inch)**] [**4.55 mm (0.179 inch)**] [**5.31 mm (0.209 inch)**] [**60.7 mm (0.239 inch)**].

B. Helically Corrugated Pile Shells: Manufacturer's standard, helically corrugated, uniform-diameter, steel sheet shell piles; of enough strength and thickness to remain watertight and resist distortion and buckling due to soil pressure, internal mandrel operation, or redriving. Fabricate in one-piece lengths with minimum 4.76 mm- (3/16 inch-) thick steel-plate boot continuously welded to tip.

1. Nominal Diameter: [**219 mm (8-5/8 inches)**] [**270 mm (10-5/8 inches)**] [**283 mm (11-1/8 inches)**] [**311 mm (12-1/4 inches)**] [**350 mm (14 inches)**] [**410 mm (16-1/8 inches)**].

2. Thickness: [**1.12 mm (0.048 inch), minimum**] [**1.52 mm (0.060 inch), minimum**] [**1.90 mm (0.075 inch), minimum**] [**2.66 mm (0.105 inch)**] <**Insert dimension**>.

2.2 STEEL PIPE PILES

A. Steel Pipe: ASTM A252, [**Grade 2**] [**Grade 3**]; seamless or welded.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 420 (Grade 60); deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M.

C. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 420 (Grade 60)**] [**ASTM A706/A706M**]; deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M, as follows:

1. Steel Reinforcement: [**ASTM A615/A615M, Grade 420 (Grade 60)**] [**ASTM A706/A706M**]; deformed.

E. Plain Steel Wire: ASTM A82/A82M, [**as drawn**] [**galvanized**].

F. Deformed-Steel Wire: ASTM A496/A496M.

G. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A coated, [**plain**] [**deformed**].

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II.

1. Fly Ash: ASTM C618, Class C or F.
2. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

B. Blended Hydraulic Cement: ASTM C595/C595M, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type I (PM), pozzolan-modified portland**] [**Type I (SM), slag-modified portland**] cement.

C. Normal-Weight Aggregates: ASTM C33/C33M, [**Class 4S**] [**Class 4M**] [**Class 1N**] <**Insert class**>, uniformly graded, 19 mm (0.75 inch) maximum aggregate size. Provide aggregates from a single source.

D. Water: Potable, complying with ASTM C94/C94M requirements.

E. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain no more than 0.1 percent chloride ions by mass of cementitious material.

1. Air-Entraining Admixture: ASTM C260/C260M.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Retarding Admixture: ASTM C494/C494M, Type B.
4. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
7. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.5 PILE ACCESSORIES

A. Driving Points: Manufacturer's standard 60-degree conical driving point, with integral reinforcing ribs, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

B. Inside Cutting Shoes: Manufacturer's standard, inside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

C. Outside Cutting Shoes: Manufacturer's standard, outside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:

1. Carbon-Steel Castings: ASTM A27/A27M, [**Grade 450-240 (Grade 65-35), heat treated**] [**or**] [**Grade N1**].

2. High-Strength Steel Castings: ASTM A148/A148M, [**Grade 550-275 (Grade 80-40)**] [**or**] [**Grade 620-415 (Grade 90-60)**].

D. Splice Coupling: Manufacturer's standard splice coupling, rolled from ASTM A36/A36M, carbon-steel bar or cast from heat-treated carbon steel, ASTM A27/A27M, Grade 450-240 (Grade 65-35), with interior stop and internally tapered for friction fit driving.

2.6 PAINT

A. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, [**black**] [**red**] [**manufacturer's standard color**].

2.7 CONCRETE MIXES

A. Prepare concrete design mixes according to ACI 301, determined by either laboratory trial batch or field test data basis.

1. Use a qualified testing agency for preparing and reporting proposed mix designs determined by laboratory trial batch.

B. Proportion mixes according to ACI 301 to provide normal-weight concrete suitable for piles with the following properties:

1. Compressive Strength (28 Days): [**34.5 MPa (5000 psi)**] [**27.6 MPa (4000 psi)**] [**20.7 MPa (3000 psi)**] <**Insert value**>.

2. Maximum Water-Cementitious Material Ratio at Point of Placement: [**0.45**] [**0.50**] <**Insert ratio**>.

3. Slump Limit: [**127 mm (5 inches)**] [**203 mm (8 inches)**] <**Insert dimension**>, plus or minus 25 mm (1 inch).

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of [**6.0 percent, plus or minus 1.5**] [**2.5 to 4.5**] percent.

D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

E. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**] [**0.30**] percent by weight of cement.

F. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval from Project Director/COR of proposed changes to concrete-mix proportions.

2.8 FABRICATION

A. Fabricate and assemble piles in shop to greatest extent possible.

B. Fabricate full-length piles to eliminate splicing during driving.

C. Fabricate full-length piles by splicing pile lengths together. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.

1. Splice Coupling: Fit splice coupling into position and weld to adjoining steel pipe pile sections according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

2. Welded Splices: Accurately mill meeting ends of steel pipe piles, and bevel for welding. Continuously weld pile according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

3. Welded Splices: Continuously weld steel-shell pile according to manufacturer's written instructions and AWS D1.1/D1.1M[**and AWS D1.3/D1.3M**] for procedures, appearance and quality of welds, and methods used in correcting welding work.

4. Splice piles during fabrication or field installation.

D. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

E. Fit and weld cutting shoes to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.

F. Pile-Length Markings: Mark each pile with horizontal lines at 305 mm (12 inch) intervals; label the distance from pile tip at 1524 mm (60 inch) intervals. Maintain markings on piles until driven.

2.9 SHOP PAINTING

A. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:

1. Extend painting to a depth of 1524 mm (60 inches) below [**finished grade**] [**low-tide level**] to top of exposed pile.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, and remove spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."

C. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than 0.2 mm (8 mils).

1. Apply second coat to provide a dry film thickness of not less than 0.2 mm (8 mils), resulting in a two-coat paint system thickness of not less than 0.4 mm (16 mils).
2. Apply second and third coats with each coat having a dry film thickness of not less than 0.2 mm (8 mils), resulting in a three-coat paint system thickness of not less than 0.6 mm (24 mils).
3. Mark pile lengths after shop painting.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with ASTM C94/C94M.

1. Do not add water to concrete mix after mixing.
2. Maintain concrete temperature to not exceed 32 deg C (90 deg F).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 152 to 305 mm (6 to 12 inches) above bottom of footing or pile cap.

3.2 DRIVING EQUIPMENT

A. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.

B. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.

C. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that hold the full length of pile firmly in position and in axial alignment with hammer.

D. Mandrel: Expandable mandrel, capable of distributing driving energy throughout length of steel-shell pile.

3.3 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcement cages symmetrically about axis of pile [**shell**] [**pipe**] in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover on reinforcement.

E. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

A. Do not place concrete until other piles within a radius of [**6 m (20 feet)**] <**Insert value**> have been driven and approved.

B. Inspection: Before placing concrete, allow testing and inspecting agency to visually inspect and verify that each pile [**shell**] [**pipe**] is clean, watertight, plumb, and free of distortion or other defects.

C. Place concrete in a continuous operation and without segregation immediately after cleaning out pile [**shell**] [**pipe**].

D. Place concrete by means of bottom discharge bucket, flexible drop chute, or steep-sided funnel hopper or tremie or pump concrete into place.

E. Place concrete in a dry pile [**shell**] [**pipe**] unless placement underwater is approved by Project Director/COR.

1. Place concrete underwater by tremie method or pumping. Control placement operations to ensure tremie is embedded no less than 1524 mm (60 inches) into concrete, and flow of tremie concrete is continuous from bottom to top of pile [**shell**] [**pipe**].
2. Other methods of depositing concrete may be used if approved by Project Director/COR.

F. Consolidate final 3 m (10 feet) of concrete during placement to ensure that concrete is thoroughly worked around steel reinforcement and into corners.

G. Screed concrete level at cutoff elevation and apply a scoured, rough finish.

3.5 DRIVING PILES

A. General: Continuously drive piles to elevations or penetration resistance indicated [**or established by static load testing of piles**]. Establish and maintain axial alignment of leads and piles before and during driving.

B. Predrilling: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.

1. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.

C. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.

D. Pile Splices: Splice piles during installation and align pile segments concentrically.

E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:

1. Location: 102 mm (4 inches) from location indicated after initial driving, and 152 mm (6 inches) after pile driving is completed.
2. Plumb: Maintain 1 inch (25 mm) in 1219 mm (48 inches) from vertical, or a maximum of 102 mm (4 inches), measured when pile is aboveground in leads.

3. Batter Angle: Maximum 25 mm (1 inch) in 1219 mm (48 inches) from required angle, measured when pile is aboveground in leads.

F. Excavation: Clean out steel pipe pile by removing soil and debris from inside pile before placing steel reinforcement or concrete.

G. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.

1. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 1830 mm (72 inches).
2. Fill holes left by withdrawn piles as directed by Project Director/COR.

H. Abandon and cut off rejected piles as directed by Project Director/COR. Leave rejected piles in place, and install new piles in locations as directed by Project Director/COR.

I. Cut off tops of driven piles square with pile axis and at elevations indicated.

J. Pile-Driving Records: Maintain accurate driving records for each pile [**, compiled and attested to by a qualified professional engineer**]. Include the following data:

1. Project name and number.
2. Name of Contractor.
3. Pile location in pile group and designation of pile group.
4. Sequence of driving in pile group.
5. Pile dimensions.
6. Ground elevation.
7. Elevation of tips after driving.
8. Final tip and cutoff elevations of piles after driving pile group.
9. Records of redriving.
10. Elevation of splices.
11. Type, make, model, and rated energy of hammer.
12. Weight and stroke of hammer.
13. Type of pile-driving cap used.
14. Cushion material and thickness.
15. Actual stroke and blow rate of hammer.
16. Pile-driving start and finish times, and total driving time.
17. Time, pile-tip elevation, and reason for interruptions.
18. Number of blows for every 305 mm (12 inches) of penetration, and number of blows per 25 mm (1 inch) for the last 152 mm (6 inches) of driving.
19. Pile deviations from location and plumb.
20. Pre-boring, jetting, or special procedures used.
21. Unusual occurrences during pile driving.

K. Certified Piles Survey: Engage a [**land surveyor**] [**professional engineer**] to prepare a piles survey showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Project Director/COR when deviations from locations exceed allowable tolerances.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**] [**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile foundations.
2. <**Insert special inspections**>.

B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D4945 during initial driving and during restriking on [**five single**] [**3 percent of**] <**Insert number or percent of**> piles.

2. Low-strain integrity measurement shall be performed and reported for each pile.

3. Weld Testing: In addition to visual inspection, welds shall be tested and inspected according to AWS D1.1/D1.1M and the inspection procedures listed in subparagraphs below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

   a. Liquid Penetrant Inspection: ASTM E165.
   b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   c. Radiographic Inspection: ASTM E94; minimum quality level "2-2T."
   d. Ultrasonic Inspection: ASTM E164.

4. Concrete: Sampling and testing of concrete for quality control shall include the following:

   a. Sampling Fresh Concrete: ASTM C172/C172M, except modified for slump to comply with ASTM C94/C94M.

      1) Slump: ASTM C143/C143M; one test at point of placement for each compressive-strength test, but no fewer than one test for each concrete load.
      2) Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 5 deg C (40 deg F) and below or when 27 deg C (80 deg F) and above, and one test for each set of compressive-strength specimens.
      3) Compression Test Specimens: ASTM C31/C31M; one set of [**four**] <**Insert number**> standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.

      4) Compressive-Strength Tests: ASTM C39/C39M; one set for each truck load. One specimen shall be tested at seven days, two specimens shall be tested at

28 days, and one specimen shall be retained in reserve for later testing if required.

b. When frequency of testing provides fewer than five strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
c. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.
d. Strength level of concrete is considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 3.45 MPa (500 psi).
e. Test results shall be reported in writing to Project Director/COR, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in piles, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
f. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as sole basis for acceptance or rejection.
g. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.

D. Concrete-filled steel piles will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 TOUCHUP PAINTING

A. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.

1. Apply touchup paint before driving piles to surfaces that are immersed or inaccessible after driving.

3.8 DISPOSAL

A. Remove withdrawn piles and cutoff sections of piles from site, and legally dispose of them off USG property.

END OF SECTION 316223

SECTION 316316 - AUGER CAST-IN-PLACE PILES (ACIP)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Documents and general provisions of the Contract, including OBO Contract Clauses and Supplementary Conditions and Division 1 Specification Sections of these Contract Specifications, apply to work of this Section.

B. Available information for reference as part of the request for proposal and bidding include the following:

1. Plan Set(s) ____, Project No. _____, prepared by _____, dated _____.
2. Geotechnical Report No.(s)_____, Project No. _____, prepared by _____, dated _____, included or referenced in the bid documents, containing the results of exploratory borings, observation pits, or other site investigation data obtained in the vicinity of the proposed CFA pile locations.

1.2 SUMMARY

A. Section includes auger cast in-place (ACIP) constructed by rotating a hallow-stem auger in the ground to a specified pile depth. Grout or concrete is injected through the hollow-stem auger under continuous positive pressure as the auger is withdrawn. Reinforcing steel, as specified, is inserted into the column of fluid grout or concrete following the completion of grout or concrete placement.

B. Related Sections include the following:

1. Division 1 Section "Unit Prices" for a schedule of unit prices.
2. Division 1 Section "Construction Facilities and Temporary Controls."
3. Division 3 Section “Cast-in-Place Concrete”: For requirements for reinforcing steel, accessories and grout provided under this Section.

1.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. ACIP piles must be the location(s), number, and diameter(s) as specified on the project plans.

B. The ACIP piles must have:

1. Allowable vertical load capacity as specified on the project plans.
2. Allowable uplift load capacity as specified on the project plans.
3. Allowable lateral load capacity as specified on the project plans.

C. ACIP piles must extend to the estimated tip elevation(s) indicated on the project plans or to prior refusal, whichever occurs first. The ACIP pile contractor must define the proposed refusal criteria in a method statement submittal that must be reviewed by the Geotechnical Engineer prior to starting the work.

D. Pile length must be determined by Pile Subcontractor, in accordance with requirements herein, as necessary to achieve designated pile design loads. The pile length shown on the drawings is an estimated length to achieve pile capacity based on the geotechnical report.

1. Refer to Geotechnical Engineering report for anticipated soil conditions.
2. Adjustments to pile length must not be measured for payment.

E. Pile reinforcement shown on drawings is a reference design. Pile subcontractor must design the pile reinforcement based on the design loads provided on the drawings and along with the information provided in the geotechnical report to meet code requirements.

F. Quality:

1. The as-built diameter of the pile must be greater than or equal to the design diameter along the entire length of the pile. Pile system or installation methods must prevent necking.
2. The strength and stiffness of grout or concrete fill must be uniform along the entire length of the pile. Pile system or installation methods must prevent contamination of grout by groundwater or soil.
3. The Owner reserves the right to request additional information to evaluate the proposed pile system.

1.4 REFERENCES

A. Standards and reference documents listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

B. ACI: Standards of the American Concrete Institute (ACI) apply where designated in this section.

1. ACI 301 - Specifications for Structural Concrete for Buildings.
2. ACI 318 - Building Code Requirements for Reinforced Concrete, 2014.

C. American Society for Testing and Materials (ASTM):

1. C 33: Specifications for Concrete Aggregates
2. C 39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
3. C 150: Standard Specification for Portland Cement
4. C 494: Standard of Specification for Chemical Admixtures for Concrete
5. C 618: Standard Specification for Fly Ash and Raw or Calcinized Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
6. C 942: Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
7. D 1143: Standard Test Method for piles under static axial compression load.
8. C1611: Standard Test Method for Slump Flow of Self-Consolidating Concrete.

9. D 3689: Standard Test Method for individual piles under static axial tension load.
10. D 4945: Standard Test Method for High Strain Dynamic Testing of Piles

D. Overseas Building Operations Building Code.

E. Concrete Reinforcing Steel Institute's (CRSI)

1. Manual of Standard Practices

F. Deep Foundation Institute

1. Inspector's Guide to Augered Cast-In-Place Piles.

G. Federal Highway Administration

1. FHWA-HIF-07-03 – Design and Construction of Continuous Flight Auger (CFA) Pile.

H. Geotechnical Report

1.5 SUBMITTALS

A. Design Submittals: must include design calculation detailing dimensions, quantities, ground profiles, cross-sections necessary to design the ACIP. Design submittals must include:

1. A written summary report of the overall pile design.
2. Applicable codes requirements.
3. Design criteria, including soil/rock shear strengths (friction angle and cohesion), unit weights, unit skin friction values, and unit end-bearing values. Any additional subsurface borings, laboratory work, or other subsurface data collected for the design must also be included.
4. Safety factors used in the deigns.
5. Seismic design earthquake acceleration coefficient or the seismic design criteria applicable for the area.

B. Working Drawings: Must include all information required for the construction and quality control of the ACIP. Working drawings must include:

1. Plan view of the ACIP, reference baseline datum.
2. Offset from the construction centerline or baseline to the face of the ACIP structure at all changes in horizontal alignment.
3. ACIP pile location with center-to-center spacing.
4. Subsurface exploration locations shown on a plan view of the ACIP alignment with appropriate reference base lines to fix the locations of the explorations relative to the ACIP.
5. Identify each pile and indicate pile dimensions, cross sections, locations, and sizes.
6. Indicate types and configurations of reinforcement and detail fabricating.
7. Detail connections to pile caps.
8. Typical pile sections including spacing, diameter, reinforcing bar sizes, locations, and details; centralizers and spacers; and connection details to the substructure footing/pile cap.

9. Method of centralizing reinforcement, type and size of centralizing devices, and locations on reinforcing bars.

C. Design Mixtures: For each grout or concrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Test Program: At least 14-days prior to the commencement of the load test program, the contractor must submit the following specifics of the program for approval by the Geotechnical Engineer:

1. Static Load Test Procedure in accordance with ASTM D 1143 Quick Load Test Method, including details of the load testing apparatus, referencing measuring locations and devices, etc.
2. Hydraulic Jack and/or load cell calibrations. Calibrations must be current within 6 months preceding the test date.
3. The Trial Piles (a minimum of 4 are required) must be installed at the locations accepted by the geotechnical engineer. The trial drilled shafts must be located near existing borings and must avoid permanent drilled shafts (a minimum of 3 pile diameters away), to demonstrate the Installer's construction methods, equipment, standards of workmanship, and tolerances.

E. Qualification Data:

1. ACIP Pile Contractor must submit evidence that he has been engaged in the successful installation of ACIP piles for at least five years and that his crane operators or "keymen" who give directions to the crane operators have at least two years of experience in the successful installation of ACIP piles. The Contractor must furnish records of past successful experience in performing this type of work and must submit to the Engineer for review a description of the materials used and method of operations. The information furnished must demonstrate that the finished piles complying, in all respects, with the quality and properties required by the Specifications.

F. Welding certificates.

G. Installation and monitoring procedures: Provide description of drilling and grouting equipment and detailed procedure to be followed for installing piles. Describe procedures for monitoring installation. Include form proposed for preparation of standard daily log.

H. Provide the following submittals for approval in accordance with Section 01300:

1. Concrete Grout Materials Test Reports as proposed for use in grout mixes.
2. Concrete Grout Design Mix Reports listing mixes required and their respective test results.
3. CFA Pile details.
4. Electromagnetic Flow Meters and Digital Pressure Gauges data for monitoring grout flow together with electronic warning system for operator.
5. Trial pile installation logs and load test program details.
6. Installation logs for all field constructed piles including grout batch number.

7. Welding Certificates: Copies of certificates indicating compliance of welding procedures and personnel with requirements in Section 1.6 “Quality Assurance”.

I. Material Certificates: For the following:

1. Cementitious materials.
2. Grout or Concrete admixtures.
3. Steel reinforcing.
4. Steel Casing.

J. Equipment Data: Description of drilling and grout-pumping equipment including the following:

1. Type and make of drilling rig, rated capacity, and boom lengths.
2. Torque of drilling machine and horsepower of hydraulic power unit.
3. Pressure and discharge capacity of grout pump.
4. Automated monitoring equipment to be used.

K. Static Pile Test Reports: Submit within seven days of completing each test.

L. Record Documents:

1. Submit two copies of the placing record of each pile to the Engineer not later than two (2) days after placement.
2. Daily logs: In accordance with approved installation and monitoring procedures. The testing and inspection agency will compile final report based on daily logs and their observations.
3. As-built survey: Plan location and elevation of pile heads and deviation from indicated locations, prepared by a licensed land surveyor.
4. Record drawing: Accurately record the following on project record drawing:

   a. Pile location, where location exceeds specified tolerances.
   b. Final tip elevation.

1.6 PREINSTALLATION CONFRENCE:

A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

B. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule activities and identify contractual relationships and delineation of responsibilities among the prime Contractor and various Subcontractors.

1. The Engineer, prime Contractor, ACIP Contractor, Inspectors, excavation Contractor, and Geotechnical Instrumentation Specialist (if applicable) must attend the meeting.
2. During preinstallation conference, the attendance should discuss the subsurface conditions, pile installation and testing, quality control and assurance plan, pile structure survey control, site drainage control, review proposed drill rig to be used, and any other detail that may affect the construction ACIP.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

B. Installer:

1. Installer Qualifications: An Experienced installer that has demonstrated specialized experience in CFA pile installation with at least five years of experience successfully installing CFA Piles. Not less than three successfully completed contracts with similar soil conditions, shaft sizes, depths, and volumes of Work contained in this Project.
2. Have present on the site at all times while work is in progress at least one authorized representative fully experienced in the installation of CFA piles. The representative must be competent to receive and carry out instructions which may be given by proper authority and to act in full capacity on behalf of the installer.
3. Certificates of material properties, indicating compliance with specified requirements, may be submitted in lieu of testing when acceptable to Architect. Certificates of Compliance must be signed by materials producer and Contractor.

C. Inspections and testing must be performed by Quality Control Manager in accordance with requirements of this Section and Division 01 Section “Contractor’s Quality Control.”

D. Mix Designs: For each type of grout or concrete **[include if applicable]**. Include description of type and proportions of ingredients.

E. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for CFA piles. Before excavating, lay out each CFA pile to lines and levels required. Record actual measurements of each CFA pile’s location, diameter, bottom and top elevations, deviations from specific tolerances, and other specified data.

1. Record and maintain information pertinent to each CFA pile and cooperate with the testing and inspecting agency to provide data for required reports.

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.8 PRECONSTRUCTION TESTING

A. Test Piles: Construct at diameter, depth, and at locations indicated on Drawings or, if not indicated, of same diameter and depth as largest production piles and at locations selected by Architect or its Design Engineer, to confirm allowable load of piles and demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.

B. The complete installation process and equipment used during the pre-production test pile program must be used to install the production piles. Sampling and testing of materials used on the project must also be included in the conformance testing plan.

1. If Architect determines that test pile does not comply with requirements, excavate for and cast another until it is accepted.
2. Tests: Arrange and perform the following pile tests:

   a. Axial Compressive Static Load Test: ASTM D1143/D1143M, Procedure A, Quick Test **[and the following Procedures:**][**.**]

      1) Procedure B, Maintained Test.
      2) Procedure C, Loading in Excess of Maintained Test.
      3) Procedure G, Cyclic Loading Test.

   b. Axial Tension Static Load Test: ASTM D3689.
   c. Lateral Load Test: ASTM D3966.

3. Equip each test pile with two telltale rods, according to ASTM D1143/D1143M, for measuring deformation during load test.
4. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

   a. Allow a minimum of twenty-eight days to elapse after installing test piles before starting pile testing.
   b. Number of Test Piles: [**One pile**] [**As indicated**] <**Insert number**>.

5. Approval Criteria: Allowable load must be the load acting on the test pile when [**the lesser of**] the following criteria are met, divided by a factor of safety of [**2**] <**Insert value**>:

   a. Net settlement of not more than 0.25 mm/907 kg of test load.
   b. Total settlement of 25 mm provided the load settlement curve shows no sign of failure.
   c. A plunging failure or sharp break in the load settlement curve.

6. Test Pile Records: Prepare records for each test pile [**, compiled and attested to by a qualified professional engineer**]. Include same data as required for permanent piles.
7. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.9 DELIVERY, STORAGE AND HANDLING

A. Store materials in orderly manner above ground and stabilize with blocks during storage to minimize possible distortion of members. Materials exhibiting variations beyond tolerance limits will be considered distorted and may not be used in the work.

1.10 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile excavation.

B. Existing Utilities: Locate existing underground utilities before installation of CFA piles. If utilities are to remain in place, provide protection from damage during pile operations.

1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult Architect immediately for directions as to procedure. Cooperate with Owner and utility companies in keeping services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

C. Site Information: A geotechnical report has been prepared for this Project and is available for information only. The report is not part of the Contract Documents. Opinions expressed in this report are those of the geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.

1. Make additional test borings and conduct other exploratory operations as necessary.
2. The geotechnical report is included elsewhere in the Project Manual.

D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for auger cast grout piles. Before excavating, lay out each pile to lines and levels required. Record actual measurements of each pile's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

E. Existing Adjacent Facilities: Take extraordinary precautions concerning the preservation of adjacent properties. Before beginning construction, the Contractor must ascertain that the structures are sound and agree to assume responsibility for the safety and preservation of the adjoining property.

F. Examine foundation drawings for existing structures. Plan and execute operations in a manner that will prevent damage to the existing foundations.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 420, deformed.

B. Single Bar Reinforcing: ASTM A722/A722M, high strength, threaded.

1. Mechanical Couplings: Screw-on type, capable of supporting the minimum ultimate tensile strength of the coupled bars.

C. Centralizers: Devices to center steel reinforcement in excavation; spaced not less than 6 m o.c. for vertical piles.

2.2 GROUT MIXTURES:

A. Prepare design mixtures for each type and strength of grout, proportioned on the basis of laboratory trial mixture, field test data, or both.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Proportion grout mixture as follows:

1. Minimum Compressive Strength: [**34.5 MPa (5000 psi)**] [**31 MPa (4500 psi)**] [**27.6 MPa (4000 psi)**] <**Insert value**> at 28 days; ASTM C109/C109M with cube specimens restrained from expansion according to ASTM C942.
2. Maximum Water-Cementitious Materials Ratio: [**0.43**] [**0.38**] <**Insert ratio**>.
3. Grout Flow: [**10 to 25 seconds**] <**Insert flow rate**>; ASTM C939 and ASTM C109/C109M using a flow cone with 19 mm (0.75 inch) opening. Grout must be designed so as to maintain the range of acceptable fluid consistency for a period of at least 2 hours **[insert time**] or longer.

2.3 CONCRETE MATERIALS: THE CONCRETE MUST BE MIXED SO THAT THE CONCRETE WILL EXHIBIT THE PROPERTIES NOTED IN SECTION 1.7.B.

A. Portland Cement: ASTM C150/C150M, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**].[**Supplement with the following:**]

1. Fly Ash: ASTM C618, [**Class C**] [**Class F**].

B. Fine Aggregate: ASTM C33/C33M with 100 percent passing a 2.36 mm (No. 8) sieve, free of materials with deleterious reactivity to alkali in cement. Provide aggregate from single source.

C. Water: ASTM C94/C94M and potable.

D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
3. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
4. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

E. Fluidifier: ASTM C937, with expansion of less than 4 percent.

2.4 RELATED MATERIALS

A. Pile-Top Forms: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes. Provide units with enough wall thickness to resist plastic concrete loads without detrimental deformation. Diameter same as pile diameter.

2.5 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.6 GROUT MIXING

A. Ready-Mixed Grout: Measure, batch, mix, and deliver according to ASTM C94/C94M, and furnish batch ticket information.

1. Temperature Limits: Comply with ACI 305.1 for hot weather and ACI 306.1 for cold weather.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, and other hazards created by drilling operations.

B. Rough grade ground elevation at pile locations to a minimum of 305 mm above required cutoff elevation.

3.2 DRILLING AND PUMPING EQUIPMENT

A. Drilling Rig: Capable of advancing hollow-stem, continuous-flight augers of design diameters to depths 20 percent greater than design depths; with stabilizing arm at bottom of leads to prevent rotation, and middle guide for augers greater than 12 m in length.

1. Mark leads at maximum 1500-mm intervals to facilitate measurement of penetration.

B. Hollow-Stem Auger: Continuous auger flighting without gaps or breaks, of diameter no more than 3 percent less than pile diameter; with grout pumping hole at bottom of auger head below cutting teeth. Seal grout-pumping hole with temporary tip plug to be fully opened by grout pressure or reinforcing bar during grout installation. The length of any auger brought to the project site must be such that the auger can install a pile to a depth that is 20% greater than the depth of the pile shown on the approved working drawings.

1. Hollow Shaft Diameter: Minimum 32-mm clear ID.

C. Grout Pump: Positive-displacement pump with a known volume per stroke. Minimum displacement pressure at pump of 2.4 MPa. The ACIP Contractor must provide the Engineer with the value of the volume of grout or concrete delivered by each stroke of the pump and must demonstrate to the Engineer that the actual volume delivered by each stroke of the pump is within 3% of the value provided. The volume per stroke must be recalibrated when the Engineer suspects that the grout or concrete delivery performance has changed.

D. Automated Monitoring Equipment: Capable of measuring auger depth, penetration rate, and grout volume pumped per unit depth increment and of printing results.

3.3 DRILLING

A. Prevent surface water from entering excavated piles. Conduct water to site drainage facilities.

B. Advance auger at a continuous rate during insertion that prevents removal of excess soil.

C. Drilling must advance through whatever materials are encountered, to the dimensions and elevations required by the Pile Contractor's design, as shown on the approved working drawings.

D. Drilling must not commence until sufficient supply of grout or concrete is present on the project site to complete the pile.

E. The same procedures used to install the test piles must be used to install production piles.

F. The center of any pile must be within 75 mm **[updated as needed]** of the location shown on the approved working drawings in a horizontal plane (i.e., plan-view).

G. Excavate piles to [**elevations indicated**] [**auger refusal**] [**elevations indicated or auger refusal**]. Establish and maintain axial alignment of leads and shaft before and during driving.

1. Auger Refusal: Rate of less than [**0.3 m/s (1 fpm)**] <**Insert value**>.

H. Drilling Tolerances:

1. Location: Pile centers maximum 75 mm from locations indicated.
2. Plumb: Within 2 percent from vertical.
3. Batter Angle: Within 4 percent from required angle.
4. Deviations in excess of the above must be cause for pile rejection and replacement piles will be at the expense of the Contractor.
5. Top of finished piles must be within the tolerance range indicated on the Structural Drawings.
6. Fill all temporary holes that are not pile holes with grout.
7. Where specified tolerances are exceeded, provide corrective construction to compensate for eccentricity as determined by Owner's Representative.

3.4 INSTALLATION

A. Maintain positive (clockwise) rotation of auger during withdrawal. Promptly remove excavated spoils to prevent accumulation.

B. Grout Placement: Place grout in continuous operation.

1. Grout or concrete placement must commence within 5 minutes after the auger has achieved the planned depth.
2. Lift auger 6 to 12 inches 152 to 305 mm (6 to 12 inches) at start of grout pumping to facilitate tip plug removal, then return to previously established tip elevation.
3. Develop an initial grout head of [**1500 mm (60 inches)**] <**Insert dimension**> before start of auger withdrawal and maintain during extraction.
4. Monitor pumped grout volumes using automated monitoring equipment.
5. Volume of placed grout is at least [**115**] <**Insert number**> percent of theoretical volume. If less than required volume is placed for any given 1500 mm (60 inch) segment, lower auger a minimum of 1500 mm (60 inch), or to bottom of pile if less than 1500 mm (60 inch) available, and restart withdrawal.
6. If grout pumping is interrupted during placement, lower auger a minimum of 1500 mm (60 inch) or to bottom of pile if less than 1500 mm (60 inch) available, and restart withdrawal.
7. If placement of grout or concrete is suspended for any reason, such as equipment failure, the pile will need to be re-drilled. The pile may be re-drilled in the same location if the grout or concrete is still fluid enough for the drill rig to penetrate. If the concrete or grout has set, the pile will need to be re-drilled in a new location.

C. Steel Reinforcement Installation, General: Comply with recommendations in CRSI's "Manual of Standard Practice."

1. Any required reinforcing steel must be placed as shown on the plans by lowering the steel into the grout or concrete column while it is in a fluid state.
2. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with grout.
3. The reinforcing steel must not be spliced except at locations that are shown on the plans.
4. Screen pile top to remove spoils immediately after auger withdrawal and before placing reinforcement.
5. The reinforcing steel must be placed in the grout column immediately after screening the grout or concrete and before the grout or concrete begins to set.
6. The steel may be lowered into the grout or concrete by gravity or pushed gently to final position by hand. The reinforcing steel must not be vibrated, driven, or otherwise guided into position by mechanical means.
7. The reinforcing steel must be held in position at the ground surface within the fluid grout column by supports appropriate for the reinforcement used, which must remain in place until the grout reaches its initial set, or 24 hours, whichever is longer.

D. Single Bar Reinforcing: Install through center of hollow-stem auger before grout placement.

E. Reinforcing Cages: Install immediately after grout placement and support at ground surface until initial set. Allow cages to fall into shaft freely under their own weight; do not force by vibrating or pushing with mechanical equipment.

F. Adjacent Piles: Do not install piles within [**6 pile diameters**] <**Insert dimension**> of piles grouted within the previous [**12**] <**Insert duration**> hours.

G. Pile Completion:

1. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation with pile-top form.
2. Where cutoff elevation is below the ground elevation, cut off top of piles at elevations indicated by removing fresh grout from the top of pile or cutting off hardened pile top after initial set.
3. The finished top of pile must be no more than 25 mm (1 inch) below or 75 mm (3 inch) above the elevation shown on the approved working drawings.

H. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Architect for review before proceeding.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: [**Owner will engage**] [**Engage**] a qualified special inspector to perform the following special inspections:

1. Pile drilling, grout or concrete placement, and testing.
2. Steel reinforcement welding.

B. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

C. Grout Tests: Testing of samples of fresh grout obtained according to ASTM C172/C172M must be performed according to the following requirements:

1. Flow Rate: ASTM C939 and ASTM C109/C109M using a flow cone with 19 mm (0.75 inch) opening.
2. Compressive Strength: ASTM C109/C109M with cube specimens restrained from expansion according to ASTM C942.

a. Testing Frequency: Obtain [**six**] <**Insert quantity**> 101 mm (2 inch) cubes for each 38 cu m (50 cu yd) or fraction thereof of grout placed, but not less than one set for

each day's pour. Obtain an additional set of cubes from each truck during test pile placement.

b. Test two cubes at 7 days, two cubes at 28 days, and hold two cubes in reserve.
c. Strength of each grout mixture is satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than [**3.4 MPa (500 psi)**] <**Insert value**>.
d. Report test results in writing to Architect, grout manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of placement, name of testing and inspecting agency, location of grout batch in Work, design compressive strength at 28 days, grout mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
e. Additional Tests: Testing and inspecting agency to make additional tests of grout if test results indicate that compressive strengths or other requirements have not been met, as directed by Architect. Additional samples may be required at the discretion of the Engineer at any time during the grout or concrete placing process to ensure that consistent fluidity/slump is being achieved.
f. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
g. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Low-Strain Integrity Testing:

1. Performed and reported according to ASTM D5882 on [**five single**] [**3 percent of**] <**Insert number or percent of**> piles and reported for each pile.
2. Such tests include, but are not limited to, sonic echo tests, impulse-response tests, cross-hole sonic tests, and backscatter gamma tests.
3. ACIP Contractor must install access tubes (of a design that is acceptable to the Integrity Testing Firm) to accommodate those tests that require access to the interior of the ACIP.

E. Pile Inspection Reports: Prepare inspection reports for each auger cast grout pile as follows:

1. Pile location.
2. Pile diameter.
3. Weather conditions.
4. Ground surface elevation.
5. Pile (bottom) depth elevation.
6. Elevation of top of grout or concrete.
7. Final length.
8. Final top centerline location and deviations from requirements.
9. Variation from plumb.
10. Date and time of beginning drilling, completion of drilling, beginning of grout or concrete pumping, completion of grout or concrete pumping, and placement of reinforcing steel.
11. Depth, position and condition of reinforcing steel and splices or mechanical couplings.

12. Details of the reinforcing steel (number, size, and grade of longitudinal bars, size and spacing of transverse steel; outside diameter and length of cage).
13. Theoretical volume of drilled hole (theoretical diameter = diameter of auger).
14. Automatic monitoring equipment record including grout volume pumped.
15. Grout testing results.
16. Remarks, unusual conditions encountered, and deviations from requirements.

F. Certified Piles Survey: Prepared by a qualified land surveyor or professional engineer showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

G. ACIP will be considered defective if they do not pass tests and inspections. Further, ACIP will be considered unacceptable if they do not meet the project performance criteria with regard to load carrying capacity and deflection.

H. Prepare test and inspection reports.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 316316

SECTION 316329 - DRILLED CONCRETE SHAFTS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Related Sections include the following:

1. Specification 033000 “Cast-in-Place Concrete” for general structural and building applications of concrete and for drilled shafts, concrete materials, mix design and mixing requirements.
2. Federal Highway Administration (FHWA) “Drilled Shafts: Construction Procedures and LRFD Design Methods,” Publication No. FHWA-NHI-10-016.
3. Section 312000 “Earth Moving.”
4. Section 312319 “Dewatering.”
5. Section 315000 “Temporary Excavation Support.”

1.2 SUMMARY

A. Section Includes:

1. Dry-installed drilled shafts.
2. Slurry displacement-installed drilled shafts.
3. Dry-installed or slurry displacement-installed drilled shafts at Contractor's choice.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. to comply with requirements in Division 01 Section "Construction Execution and Coordination."

B. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

C. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule activities and identify contractual relationships and delineation of responsibilities among the prime Contractor and various Subcontractors.

1. The Engineer, prime Contractor, drilled piers Contractor, Inspectors, excavation Contractor, and Geotechnical Instrumentation Specialist (if applicable) must attend the meeting.
2. During preinstallation conference, the attendance should discuss the subsurface conditions, pile installation and testing, quality control and assurance plan, pile structure survey control, site drainage control, review proposed drill rig to be used, and any other detail that may affect the construction drilled piers.
3. Review methods and procedures related to drilled shafts including, but not limited to, the following:

a. Review geotechnical report.
b. Discuss existing utilities and subsurface conditions.
c. Review coordination with temporary controls and protections.
d. Review of QA/QC and safety procedures.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Pier Location Plan: Provide a plan clearly showing the designation and location of all drilled shafts, including trial drilled shafts, by an identifying system, including the planned tip and design cut-off elevations for all piers. The plan must include the location of the centerline of each pier by a coordinate system from an approved reference working point.

C. Drilled Shaft Installation Method Statement: Prior to beginning of drilled shaft construction, the Contractor must submit a drilled shaft method statement giving the amount and characteristics of equipment to be used in the work, schedule for performing the work, and method and sequence for the construction of both dry (if applicable) and wet drilled pier construction. The following must be submitted together with the means and methods for installing test drilled pier and plumbness, where applicable.

1. A complete description of the drilled pier installation equipment, including casing.
2. Installation Method. Submit procedures of the installation method, including (where applicable) type of drilling rigs and equipment, casing size and length, casing removal method, drilling fluid type, dewatering method (if necessary), concrete placement, details of tremie and sealing technique, and reinforcing steel securing and placement.
3. Additional for Wet Method Installation Method: Submit procedures of the installation method including slurry operation, means and methods for utilizing slurry including de-sanding, handling, storage, testing and disposal, if required. Also submit means and methods for stabilizing and cleaning shaft excavations.
4. Inspection Devices: Submit procedures and equipment information on shaft inspection devices for inspecting and verifying the pier bottom conditions as well as the diameter and plumbness.
5. Submit procedures for tremie concrete. Submit a detailed procedure for construction of both dry and wet drilled shaft construction techniques, if deemed applicable.
6. Identification of pier concrete and reinforcement, and procedures for placing reinforcing and tremie concrete.
7. The planned use of cleanout buckets, hydraulic lifts, and alternative systems to clean the bottom of drilled piers adequately if pier design relies on end bearing.

D. Non-Destructive Testing Equipment: Submit shop drawings showing equipment and procedures to facilitate cross-hole sonic logging, pile integrity testing, or other approved method as needed.

E. Design Mixtures: Refer to Specification Section 033000 “Cast-in-Place Concrete” for drilled shaft design mix submittal requirements. For each concrete mixture, submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.
2. Laboratory Test Reports: For evaluation of concrete materials and mix design.

F. Shop Drawings: For concrete reinforcement, detailing fabricating, bending, supporting, and placing.

G. Qualification Data: For Installer, land surveyor, professional engineer, and testing agency.

H. Load Test Plan at least 14 days prior to commencement of the load test program. The plan should include at a minimum the drilled shaft schedule, sequence, load test pile locations, the reaction proposed, load testing increments and maximum loading, planned deflection measurement instrumentation, and hydraulic jack and/or load cell calibrations. Calibrations loads cells, jacks, and instrumentation must be current within 6 months preceding the test date. For axial capacity, instrumentation should be set to estimate the respective end bearing and friction contributions of the axial pile capacity.

I. Welding certificates.

J. Material Certificates: From manufacturer, for the following:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.

K. Material Test Reports: For each material below, by a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

L. Field quality-control reports and drilled shaft installation records. Submit report within 7 days of shaft installation.

M. Record drawings at Project closeout according to Division 01 Section “Closeout Procedures.”

1.5 QUALITY ASSURANCE

A. The contractor is solely responsible for quality of the Work. The contractor must implement a Quality Control Program (QCP) for the work of this section. The implementation of the QCP does not relieve the contractor from responsibility of providing the Work in accordance with the Contract Documents and all applicable codes and regulations.

B. All drilled shaft work in this project must conform to all requirements of ACI 336.1-01 and ACI 336.36R-14, except as modified by these Contract Documents.

C. Installer Qualifications: An Experienced installer that has demonstrated specialized experience in drilled shaft work with at least five years of experience successfully installing drilled shafts. The installer must have not less than three successfully completed contracts with similar soil conditions, pile sizes, depths, and volumes of Work contained in this Project.

D. Licensed Engineer: The contractor will provide the services of a licensed local or US Engineer on site during construction of the drilled shafts and load tests to confirm compliance with the contract documents.

E. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled shafts. Before excavating, lay out each drilled shaft to lines and levels required. Record actual measurements of each drilled shaft's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled shaft and cooperate with the testing and inspecting agency to provide data for required reports.

F. Testing and Inspection Agency Qualifications: A licensed local or US based geotechnical engineering approved by the Design Team and Project Director/COR after submittal of qualifications.

G. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.6 TRIAL DRILLED PIER

A. Trial Drilled Pier: Construct trial drilled pier of diameter and depth and at location indicated or, if not indicated, of same diameter and depth as largest drilled piers, located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.

1. Install reinforcement, fill with concrete, remove temporary casings, and terminate trial drilled pier 600 mm below subgrade and leave in place.
2. Install permanent casings, excavate bell, excavate rock socket, and place slurry, as required for permanent drilled piers.
3. Load testing must not be performed on any shaft until concrete has reached the minimum 28-day strength as specified in the section.
4. Cross hole sonic logging (CSL) should be performed on all trial drilled shafts and at least 15% of production drilled shafts. CSL testing must be performed in accordance with FHWA’s GEC#10 – Drilled Shaft Manual.
5. If Project Director/COR determines that trial drilled pier does not comply with requirements, excavate for and cast another until it is accepted.
6. Drilled shafts must be subjected to static load testing requirements in ASTM D1143. Strain gauge locations of test shafts should be reviewed and approved by the Geotechnical Engineer.
7. See project Geotechnical Engineering Report for additional information regarding soils, subsurface conditions, trial drilled shafts, testing, and acceptance procedures.
8. Trial drilled shafts must not be re-used as permanent drilled shafts.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled shafts. If utilities are to remain in place, provide protection from damage during drilled shaft operations.

1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Project Director/COR and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of Project Director/COR. Costs incurred by the Contractor will be compensated in accordance with the changed conditions contract section.

B. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Project Director/COR or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Project Director/COR no fewer than seven days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Project Director/COR written permission.

C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Project Director/COR is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
2. The geotechnical report is included elsewhere in the Contract Documents.

D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled shaft to lines and levels required. Record actual measurements of each drilled shaft's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and indicate on Record Drawings. Cooperate with Project Director/COR and the testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drilled-Pier Standard: Comply with ACI 336.1 except as modified in this Section.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 420, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Galvanized Reinforcing Bars: [**ASTM A615/A615M, Grade 420**] [**ASTM A706/A706M**], deformed bars, ASTM A767/A767M, [**Class I**] [**Class II**] zinc coated after fabrication and bending.

D. Epoxy-Coated Reinforcing Bars: [**ASTM A615/A615M, Grade 420**] [**ASTM A706/A706M**], deformed bars, [**ASTM A775/A775M**] [**or**] [**ASTM A934/A934M**], epoxy coated, with less than 2 percent damaged coating in each 300-mm bar length.

E. Plain-Steel Wire: ASTM A82/A82M, [**as drawn**] [**galvanized**].

F. Deformed-Steel Wire: ASTM A496/A496M.

G. Epoxy-Coated Wire: ASTM A884/A884M, Class A, Type 1 coated, [**as-drawn, plain**] [**deformed**]-steel wire, with less than 2 percent damaged coating in each 300-mm wire length.

H. Joint Dowel Bars: ASTM A615/A615M, Grade 420, plain. Cut bars true to length with ends square and free of burrs.

2.3 CONCRETE MATERIALS

A. Concrete materials must conform to Specification 033000 “Cast-in-Place Concrete.”

2.4 STEEL CASINGS

A. Steel Pipe Casings: ASTM A283/A283M, Grade C, or ASTM A36/A36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1/D1.1M.

B. Corrugated-Steel Pipe Casings: ASTM A929/A929M, steel sheet, zinc coated.

C. Liners: Comply with ACI 336.1.

2.5 SLURRY

A. Slurry: [**Pulverized bentonite**] [**pulverized attapulgite**] [**or**] [**polymers**] mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH.

B. Water may be used as slurry when casing is used for the entire length of the drilled hole, provided that the method of drilled shaft installation maintains stability at the bottom of the shaft

excavation. A water slurry is water that is maintained as clean a possible during its use. Water slurry must comply with API 13B-1 Section 1 for density and sand content.

2.6 CONCRETE MIXTURES

A. Refer to specification Section 033000 for Concrete Mixtures Requirements.

2.7 REINFORCEMENT FABRICATION

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.8 CONCRETE MIXING

A. Refer to specification Section 033000 for Concrete Mixing Requirements.

2.9 SHAFT LOAD TESTS

A. Hydraulic Jack(s) and Pressure Gauges:

1. Hydraulic jack(s) must be equipped with the necessary gauges and piping which must transmit constant load to the pier.
2. Hydraulic jack(s) must be rated for a load capacity of at least 1.5 times the total test load.
3. Hydraulic jack(s) must have sufficient ram so that the full test load can be applied at no more than 80% of its extension.
4. Pressure gauge must be able to read pressures accurately to the nearest 250 kPa and must have a range equivalent to at least twice the pressure required to maintain the full test load.
5. Hydraulic jack(s) and pressure gauge must be calibrated as a unit by a certified testing laboratory not more than Six months prior to their use at the Site. A calibration report indicating jack and pressure gauge identification numbers and a calibration curve must be submitted to the Project Director/COR at least one week prior to beginning any load tests.

B. Dial Indicators:

1. Dial gauges must be capable of reading to the nearest 0.25mm and must have a travel of at least 50mm.

C. Strain Gauges:

1. The strain gauges must be vibrating sister gauge bars, Model 4911 as manufactured by Geokon, or approved equivalent.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time are authorized for removal of obstructions.

B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

C. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.

1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
2. Remove water from excavated shafts before concreting.
3. Excavate rock sockets of dimensions indicated.
4. Excavate to the minimum tip elevations indicated on the project plans.

D. Notify and allow the testing and inspecting agency to observe and document installation of drilled shafts. These observations must be performed on a full-time basis during installation of drilled shafts. If unsuitable materials are encountered, make adjustments to drilled shafts as determined by the Geotechnical Engineer and Project Director/COR.

1. Do not excavate shafts deeper than elevations indicated unless approved by Project Director/COR.
2. Additional authorized excavation will be paid according to Contract provisions for changes in work.

E. End-Bearing Drilled Piers: Probe with auger to a depth below bearing elevation, equal to diameter of the bearing area of drilled pier. Determine whether voids, clay seams, or solution channels exist.

1. Test first three drilled piers and one of every six drilled piers thereafter.
2. Fill augur-probe holes with grout.

F. Excavate shafts for closely spaced drilled piers and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set.

G. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 2500 mm above ground-water level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.

1. Excavate and complete concreting of drilled pier on same day, or redrill, clean, and test slurry in excavation before concreting.
2. Clean bottom of each shaft before concreting.

H. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete [**, or leave temporary casings in place**].
2. The casing must be capable of being removed without deforming and causing damage to the completed shaft, and without disturbing the surrounding soil.

I. Bells: Excavate bells for drilled piers to shape, base thickness, and slope angle indicated. Excavate bottom of bells to level plane and remove loose material before placing concrete.

1. Shore bells in unstable soil conditions to prevent cave-in during excavation, inspection, and concreting.

J. Tolerances: Construct drilled shafts to remain within ACI 336.1 tolerances.

1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Project Director/COR for review with OBO/PDCS/DE/CSE input before proceeding.
2. For any location or out-of-plumb tolerances that are exceeded, and that also affect following works the Engineer may instruct that additional piles are installed at no additional cost in order to reduce/mitigate the knock-on effect of the out of tolerance drilled piers on the following works.

K. Inspection: Each drilled shaft must be inspected and tested by the testing and inspecting agency before placing concrete.

1. Provide and maintain facilities with equipment required for testing and inspecting excavations. Cooperate with testing and inspecting personnel to expedite the Work.
2. Notify Project Director/COR and testing agency at least six hours before excavations are ready for tests and inspections.

3.3 PERMANENT STEEL CASING INSTALLATION

A. Install permanent steel casings of minimum wall thickness indicated and of diameter not less than diameter of drilled pier.

1. Install casings as excavation proceeds, to maintain sidewall stability.

2. Fabricate bottom edge of lowest casing section with cutting shoe capable of penetrating rock and achieving water seal.
3. Connect casing sections by continuous penetration welds to form watertight, continuous casing.
4. Remove and replace or repair casings that have been damaged during installation and that could impair strength or efficiency of drilled pier.
5. Fill annular void between casing and shaft wall with grout.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Provide extended reinforcement as defined on the Contract Documents. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

G. Provide temporary steel to maintain shape of reinforcing cage during lifting operations.

3.5 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by the independent testing and inspecting agency.

B. Place concrete in shaft during the same working shift as completion of the drilling.

1. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete and insert joint dowel bars as required by Engineer upon review. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.

C. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
2. Vibrate top 1500 mm of concrete.

D. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping in accordance with ACI 336.3 Section 5.4. Control placement operations to ensure that tremie or pump pipe is embedded no fewer than 3000 mm into concrete, and flow of concrete is continuous from bottom to top of drilled shaft. Allow water or slurry in pier shaft to rise to a stable static level. Fill tremie pipe with sufficient concrete to release the pipe plug and discharge concrete from pipe bottom when concrete pressure exceeds the hydrostatic head. Allow the concrete to rise like a liquid from the pier bottom. Begin raising the tremie pipe after placement of the initial 3000mm of concrete depth measured from the pier bottom, then maintain pipe at not less than 3000mm constant penetration in the concrete.

1. Vibrate top 1500 mm of concrete after withdrawal of temporary casing.

E. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

F. Protect concrete work, according to ACI 301M, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

G. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to Specification 033000 “Cast-in-Place Concrete” and ACI 301M to maintain delivered temperature of concrete at no more than 32 deg C.

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

H. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 1500 mm head of concrete above bottom of casing.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: The contractor will engage a licensed local or US based independent testing and inspecting agency to sample materials, perform tests, and submit reports during excavation and concrete placement for drilled shafts.

B. Licensed Engineer: The contractor will provide the services of a licensed local or US Engineer on site during construction of the drilled piers and load tests to confirm compliance with the contract documents.

C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.

1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities are determined by testing and inspecting agency. Final evaluations and approval of data are determined by Geotechnical Engineer and Project Director/COR.

   a. Bearing Stratum Tests: Testing agency takes undisturbed [**hardpan**] [**rock**] core samples from drilled-pier bottoms; tests each sample for compression, moisture content, and density; and reports results and evaluations.

D. Concrete Tests and Inspections: ASTM C172/C172M except modified for slump to comply with ASTM C94/C94M.

1. Slump: ASTM C143/C143M; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
2. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 4.4 deg C and below and 27 deg C and above, and one test for each set of compressive-strength specimens.
3. Compression Test Specimens: ASTM C31/C31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
4. Compressive-Strength Tests: ASTM C39/C39M; one set for each drilled pier but not more than one set for each truck load. Test one specimen at seven days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
5. If frequency of testing provides fewer than five strength tests for a given class of concrete, conduct tests from at least five randomly selected batches or from each batch if fewer than five are used.
6. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor must evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
7. Strength of each concrete mixture is satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 3.4 MPa.
8. Report test results in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency to make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Architect.

a. Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

11. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. An excavation, concrete, or a drilled shaft will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports for each drilled pier as follows:

1. Actual top and bottom elevations.
2. Actual drilled-pier diameter at top, bottom, and bell.
3. Top of rock elevation.
4. Description of soil materials.
5. Description, location, and dimensions of obstructions.
6. Final top centerline location and deviations from requirements.
7. Variation of shaft from plumb.
8. Shaft excavating method.
9. Design and tested bearing capacity of bottom.
10. Depth of rock socket.
11. Levelness of bottom and adequacy of cleanout.
12. Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.
13. Ground-water conditions and water-infiltration rate, depth, and pumping.
14. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
15. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
16. Bell dimensions and variations from original design.
17. Date and time of starting and completing excavation.
18. Inspection report.
19. Condition of reinforcing steel and splices.
20. Position of reinforcing steel.
21. Concrete placing method, including elevation of consolidation and delays.
22. Elevation of concrete during removal of casings.
23. Locations of construction joints.
24. Concrete volume.
25. Concrete testing results.
26. Remarks, unusual conditions encountered, and deviations from requirements.
27. <**Insert requirement**>.

3.7 NON-DESTRUCTIVE TESTING OF DRILLED SHAFTS

A. Implement Cross-Hole-Sonic Logging (CSL) on trial shafts and at least 15% of production piers. CSL testing frequency on production shafts must be spread out evenly across entire drilled shaft construction time period.

1. A minimum of six (6), equally spaced, 3.5 to 5 cm-inside-diameter schedule 40 steel pipes must be installed into the designated piers. Pipes must be watertight and free from corrosion with clean internal and external faces to ensure passage of the probes and a good bond between the concrete and the pipes.
2. Fit each pipe with a watertight shoe on the bottom and a removable cap on the top. Securely attach the pipes to the interior of the reinforcement cage with a minimum cover of 7.5 cm. Install the pipes in each pier in a regular, symmetrical pattern such that each pipe is placed the maximum distance possible form each adjacent pipe, with an equal spacing around the perimeter of the cage.
3. Install the pipes as near as to parallel as possible. Extend the pipes as necessary to facilitate testing. Fill the pipes with clean water before concrete placement and close the pipe tops to keep debris out of the pipes.

B. Perform CSL testing in accordance with industry standards and FHWA's GEC #10 – Drilled Shaft Manual. CSL anomalies must be evaluated in accordance with guidelines of FHWA's manual with supplemental Cross Hole Tomography work being accomplished if required.

C. CSL testing must be conducted a minimum of 72 hours after the placement of concrete in the shaft but no later than 7 calendar days after placement and prior to loading for test shafts, or within 30 days after placement on production drilled shafts.

D. After the Project Director/COR and Contractor's Geotechnical Engineer have approved each individual CSL test report submitted by the specialty subcontractor, the water from within the access pipes can be removed and the pipes should be filled with grout having a minimum design compressive strength equivalent or greater than the respective pier concrete. Samples of the grout must be obtained to confirm the 28-day compressive strength of the grout utilized to fill the access pipes. Appropriate tremie techniques must be implemented to fill each access pipe from the bottom of the hole displacing the water and resulting in a properly filled and grouted hole.

E. If a defect is detected, additional evaluation should be performed. If necessary, the pier must be cored to facilitate further evaluation of the defect. The core hole must be of sufficient diameter to allow down hole inspection with a borehole type camera to provide additional qualitative information regarding the potential defect.

F. Remedial measures must be implemented as necessary by the Contractor to either sufficiently remediate the condition allowing use of the pier or alternatively replacement piers must be installed. The need and requirements for remediation or replacement must be determined by the Project Director/COR, Structural Engineer and Contractor's Geotechnical Engineer.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Government's property.

END OF SECTION 316329

SECTION 323118 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. The extent and locations of ornamental metal fences are shown on the Construction Drawings and include devices for anchorage of fence units to substrates.

B. Ornamental Metal Security Perimeter Fence installation types include the following where identified on the Construction Drawings:

1. Anti-climb fencing installed on anti-ram barrier to create an anti-ram perimeter fence.
2. Anti-climb fencing with no anti-ram perimeter barrier.

C. Ornamental Metal Control Fence installation types include the following where identified on the Construction Drawings:

1. Control fencing outside perimeter wall or fence.
2. Control fencing within perimeter wall or fence.
3. Consular barrier fence.

D. Ornamental Metal Safety Fence installation types include the following where identified on the Construction Drawings:

1. Safety fencing serving as barriers at swimming pools.

1.2 CORROSION RESISTANCE PERFORMANCE

A. Corrosion Risk: As indicated in project Contract (e.g., Statement of Work). The OBO Building Code Appendix W defined OBO Atmospheric Corrosivity Level for this site is **[Low] [Moderate] [Extreme]**. The atmospheric corrosion risk exposure risk type for a given component shall be as defined by OBO Building Code W101.1.2 (i.e., direct exterior, indirect exposure to exterior, and interior exposure only).

B. Corrosion Resistance Standards: Provide materials and finishes for the components in accordance with the material specifications of this Specification Section and the general material type as indicated by this article for the project-specific corrosion risk identified above or elsewhere in the Contract Documents.

C. Material Standards for Components for Exterior Fences: As applicable for the OBO Atmospheric Corrosivity Level (ACL) of site and for both direct exterior exposure and indirect exposure to the exterior:

1. Mild Steel: **[hot-dipped galvanized coating] [hot-dipped galvanized plus paint (duplex) coating system]**; low and moderate ACL.
2. Stainless Steel: low, moderate, and extreme ACL.

1.3 PERFORMANCE REQUIREMENTS

A. General: Performance requirements in this Article represent minimum values and qualities that are permitted for DOS facilities. On a project-specific basis, greater values and qualities may be selected; where those are indicated on Construction Drawings, the greater values take precedence over those identified in this Article. Fence details and assemblies shall enable proper application and maintenance of any intended coating systems, prevent the accumulation of standing water on surfaces or within closed sections, and mitigate galvanic interactions between any dissimilar metals.

B. Ornamental Metal Security Perimeter Fence:

1. Minimum Height: Security fence shall provide anti-climb protection for minimum of 2.75 meters (9 feet) above grade or accessible platform on attack side.
2. Intrusion Resistance: Fabricate for maximum strength against the use of ordinary hand tools to bend pickets in a manner that would enlarge openings sufficiently to allow passage of intruders through the fence.
3. Anti-Ram and Anti-Climb Design: The requirement to use anti-ram or anti-climb design for each section of perimeter fence is identified on Construction Drawings. The fence designs included in the “Physical Security Detail Handbook” reference document in the OBO Design Standards are not specifically certified by Diplomatic Security (DS); rather, these designs depict previously developed designs that have been considered acceptable by DS and OBO in terms of providing “non-climb” and “non-man-passable” design. Other designs that address those security considerations are permissible from a security standpoint.

    a. This Specification Section only addresses anti-ram design of perimeter fences regarding the ornamental metal portion of anti-ram fence assemblies and its interaction with the lower anti-ram portion of those fences.

C. Ornamental Metal Control Fence:

1. Detail, fabricate, and install fencing to match construction of anti-climb perimeter fencing used, if applicable. The control fencing shall not create a climb hazard where it intersects buildings, perimeter walls/fences and other elements.
2. Control Fence Outside Perimeter: Control fencing shall provide a minimum of 2.1 meters of non-climbable protection.
3. Control Fence Within Perimeter: Control fencing shall provide a minimum of 1.2 meters of non-climbable protection.

4. Consular Barrier: Fencing, where selected as barrier type, shall be minimum height as indicated on Construction Drawings.

D. Ornamental Metal Safety Fence: The following represent minimum safety requirements for ornamental metal safety fence around portions of pools where buildings do not provide safety barriers.

1. Fence Height: Minimum 1200 mm (48 inches) above grade measured on side of barrier that faces away from swimming pool.
2. Opening Limitations: Construct with balusters or ornamental patterns as indicated on Construction Drawings, and such that a 100 mm (4-inch) diameter sphere cannot pass through any opening.
3. Vertical Clearance at Grade: Maximum vertical clearance between grade and bottom of barrier shall be 100 mm (4 inches) measured on side of barrier that faces away from swimming pool.
4. Access Gates:

   a. Gates shall open outward away from pool, be self-closing with self-latching device, and accommodate locking device.
   b. Where fences and gates exceed minimum requirements, and if release mechanism is located less than 1370 mm (54 inches) from bottom of access point, locate release mechanism on pool side of gate at least 75 mm (3 inches) below top of access point and not higher than 1875 mm above grade.
   c. Gate shall have no opening greater than 15 mm (5/8 inch) within 450 mm (18 inches) of release mechanism.
   d. Maximum vertical clearance between grade and bottom of barrier gate shall be 100 mm (4 inches) measured on side of barrier that faces away from pool.

5. [Match style of ornamental metal fencing shown for anti-climb fencing, except that height and picket spacing shall conform to requirements above for safety fencing rather than for security fencing.]

1.4 SUBMITTALS

A. Product data for fencing systems. Include mill certificates and product data for each type and grade of metal used in fabricating units, and for bolts and accessory items used in assembly and installation. Include manufacturer's product data for materials to be used in finishing or painting fence units. Product data for coating systems shall establish appropriateness for the intended exposure to the Project site environment.

B. Shop drawings for each type and size of metal fence unit. Show layout at same scale as site plan; typical plan, elevation, and section of units, including bracing, at 1:20 scale; and joint/anchorage details at 1:5 scale. Include details of fence posts, corners, and terminations. Include structural analysis of resistance to wind loading.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code – Steel” for mild steel and AWS D1.6 “Structural Welding Code-Stainless Steel” for stainless steel.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver prefabricated fence units and support bracing/anchorage units to project site, completely assembled and prefinished, with finish fully protected during handling, shipping, storage, and delivery/installation.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Welding Rods and Bare Electrodes: Provide type conforming to fence design drawings and as recommended by applicable AWS specifications for metal/alloy being welded in each element of fence fabrication and installation.

B. Bolts and Fasteners: Where within reach from attack-face of fence, provide non-removable bolt/nut units (not removable by use of commonly available tools).

C. Concrete Inserts: Furnish anchorage units to be placed in concrete substrate; of hot-dip galvanized cast-iron/malleable-iron body. ASTM A 153 zinc coating, ASTM A 47 castings.

D. Setting/Anchoring Cement: Non-shrinking, non-staining, hydraulic-controlled expansion cementitious compound; factory prepackaged for mixing with water at project site for a pourable and trowelable mix; recommended by manufacturer for exterior exposure without protective coating, sealer, or waterproofing. Provide product equivalent to "Super Por-Rock" by Minwax Const. Products Div.

E. Expansion Shims: To allow for thermal expansion of fence units, provide fluorocarbon resin (or similar) plastic washers, pads, and slip sheets in bolted connections between units, and between fence components and anchorages.

F. Shop Primer Paint:

1. Epoxy Primer for Galvanized Steel: Complying with MPI #101 and compatible with coating to be applied over it. As applicable, conform to VOC content requirements for jurisdiction where fabrication occurs.

G. High-Performance Coating: Field-applied epoxy system over shop primer paint.

1. Intermediate coat: Epoxy, gloss, MPI #77.
2. Topcoat: Epoxy, gloss, MPI #77.

2.2 MATERIALS, GENERAL REQUIREMENTS FOR MILD STEEL FENCES

A. Plates, Bars, Angles, and Channels: ASTM A36 or ASTM A572

B. Hollow Structural Sections (steel tubes): ASTM A500 or ASTM A1085

C. Inserts, Bolts Fasteners: Standard units of strengths required to endure performances; hot-dip zinc coated in compliance with ASTM F2329.

D. Hot-Dip Galvanizing: All mild steel fence components must be hot-dip galvanized in accordance with ASTM A123.

2.3 MATERIALS, GENERAL REQUIREMENTS FOR STAINLESS STEEL FENCES

A. Stainless Steel Plates, Sheets, and Strips: AISI Type 316, 316L, 2101 or 2205 complying with ASTM A240/A240M or ASTM A895/A895M

B. Stainless Steel Bars and Shapes: AISI Type 316, 316L, 2101 or 2205 where welding is to be performed, complying with ASTM A276/A276M or A582/A582M

C. Stainless Steel Tubing: AISI Type 316, 316L, 2101 or 2205A1016/A1016M

D. Stainless Steel Wire and Rod: AISI Type 316, 316L, or as recommended by the manufacturer for AISI 2101 or 2205 steel, complying with ASTM A555/A555M

E. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers: AISI Type 316 (Alloy Group 2), complying with ASTM F593 and ASTM A594, or ASTM A193 and ASTM A194, or ASTM A320 and ASTM A194, or ASTM A1082; provide washers of compatible stainless steel alloy where appropriate.

2.4 FABRICATION

A. General: Cut and form/shape members to sizes and shapes required for assembly of fence units. Weld joints of assembly with welds all around, to produce joints of full-member-strength, with no possible moisture penetration. Grind welds reasonably smooth, but not necessarily flush. Prefabricate units in plant by welding, to the greatest extent possible. Provide bolted connections for bracing elements and similar parts, but only to the extent units must be disassembled for delivery to project and for installation.

1. Drill anchor bolt holes accurately spaced, oversized by 6 mm above bolt size, for installation tolerance.
2. Provide for thermal movement of units, amounting to plus-or-minus 1 mm in 1 meter of fence length.
3. Close ends of hollow members (pipes/tubes) which are not butt welded tight against another member in the assembly. Close with 6 mm thick steel plate, slightly recessed and welded all around for tight seal.

4. Avoid the use of bolts and screws exposed to and accessible from the threat side of fence. Where unavoidable, provide nonremovable type fasteners in the assembly.
5. Ease exposed metal edges of fabricated units, to approximately 0.8 mm radius, prior to finishing.
6. Pedestrian Gates at Control Fencing: **[Single][and] [double]** swing gates as indicated. This type of gate is not permitted for use at perimeter walls.

    a. Hinges: Offset type, malleable iron, 180-degree swing.
    b. Lock: DS-approved lock.
    c. Closer: Manufacturer's standard.
    d. Latches permitting operation from **[one side][both sides]** of gate. **[Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.]**

7. Pedestrian Gates at Safety Fencing: Single swing gates as indicated.

    a. Hinges: Offset type, malleable iron, 180-degree swing.
    b. Safety Gate Latch: Basis of Design is Top Pull model by Magna Latch with gate handle and gate stop. Provide two sets of keys. Provide round post adaptor if required for style of picket selected.
    c. Closer: Manufacturer's standard.
    d. Latches permitting operation of gate to swing outward away from the pool.

8. Stainless Steel Welded Joint Treatment: At all welded joints in stainless steel assemblies, remove oxides, carbon precipitation, and weld spatter at or around welded joints and passivate surfaces in accordance with ASTM A380 and ASTM A967.

B. Shop-applied Finish, General: Comply with applicable provisions/recommendations of NAAMM Metal Finishes Manual, the coating system manufacturer's printed instructions, and the following:

1. Prepare ferrous metal surfaces by cleaning in compliance with SSPC-SP6, "Commercial Blast Cleaning."
2. Apply shop primer paint coat in accordance with paint manufacturer's recommendations for application and baking.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate fence installation with work of other sections of these specifications. Deliver concrete inserts to Installer of concrete substrates that will support fence units, prior to time scheduled for placement of concrete. Furnish templates and complete instructions for placing inserts.

B. Check concrete substrate and anchorage inserts, for compliances and tolerances required to facilitate installation of fence units. Coordinate beginning of installation with curing of concrete

substrate, and with other work at project site; for both temporary security utilization of fence enclosure, and for preservation of metal work and finish.

3.2 INSTALLATION

A. Set plumb and level, and true to line-of-slope; accurately located with respect to adjacent units, setbacks and property lines, and adjoining work. Comply with Fabricator's instructions on unpacking, handling, preservation/removal of protective covering, and assembly of fabricated elements. Set base/support plates of units in confined bed of setting/anchoring cement, without voids. Trim away excess bedding material, and tool exposed joint faces for neat, water-resistant exposure.

B. Anchor fence units to substrate. Install fasteners in manner to prevent them from being removed.

C. Provide continuous top and bottom rails. Fabricate fencing to follow the slope of the grade with the pickets remaining vertical.

D. Complete the installation of corner posts, special bracing, gates, special security features, and other elements of the work indicated as work of this section.

E. Stainless Steel Welded Joint Treatment: At all welded joints in stainless steel assemblies, remove oxides, carbon precipitation, and weld spatter at or around welded joints and passivate surfaces in accordance with ASTM A380 and ASTM A967.

3.3 FIELD-APPLIED COATING

A. Coating Preparation: Clean exposed surfaces of fence work, and touch up abraded shop primer finishes to restore corrosion resistance in accordance with the coating system manufacturer’s printed instructions and with consideration for compatibility with the substrate material.

B. Apply high-performance coatings according to manufacturer’s written instructions and recommendations in “MPI Architectural Painting Specification Manual.”

1. Use applicators and techniques suited for coating and substrate indicated.
2. Tint each undercoat a lighter shade to facilitate identification of each coat. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
3. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
4. Apply coating to produce surface films with surface imperfections.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION 323118

SECTION 323305 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seating.
2. Bicycle racks.
3. Trash receptacles.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing pipe sleeves cast in concrete footings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

C. Samples for Verification: For each type of exposed finish, not less than 150-mm- long linear components and 100-mm- square sheet components.

D. Product Schedule: For site furnishings. **[Use same designations indicated on Drawings]**.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings manufactured with preservative-treated wood.

1. Indicate type of preservative used and net amount of preservative retained**. [For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.]**

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Trash Receptacle Inner Containers: [**Five**] <**Insert number**> full-size units for each size indicated, but no fewer than [**two**] <**Insert number**> units.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with applicable accessibility provisions in OBO-ICS Chapter 11 for seating and trash receptacles.

2.2 SEATING <**INSERT DRAWING DESIGNATION**>

A. Frame: **[Cast iron][Steel][Stainless steel][Wrought iron][Cedar][Teak]<Insert wood>**.

B. Seat**[and Back]**:

1. Steel straight-backed seat, framed with 32 mm (1-1/4 inch) O.D. 0.120 wall steel tube with four mitered corners. Insert panel constructed of 16 mm (5/8 inch) O.D. round steel rods welded to steel frame, and hardware for seat attachment.
2. Horizontal seat supports on dual 64 mm (2-1/2 inch) steel tube, adapters are welded onto tubes matching adapters are welded to seats, fasteners included with assemblies, standard vertical supports – with supports the same color as the seat.
3. Seat Surface Shape: **[Flat][Contoured or dished]**.

4. Overall Height: **[As indicated] <Insert dimension>**.
5. Overall Width: **[As indicated] <Insert dimension>**.
6. Arms: None.

7. Seating Configuration: Multiple units**[as indicated]**.

C. Steel Finish: Galvanized and color coated.

1. Color: **[Match Project Director/COR's samples] [As selected by Project Director/COR from manufacturer's full range]**.

D. Stainless Steel Finish: **[ASTM A480/A480M, No. 6] <Insert description>**.

E. Wood Finish: **[Unfinished][Factory-applied transparent finish][Factory-applied stain and transparent finish; Manufacturer's standard stain][Factory-applied opaque finish] [Manufacturer's standard finish]**.

F. **[**Fiberglass][HDPE] Color: [**Match Project Director/COR's samples**][**As selected by Project Director/COR from manufacturer's full range**].

2.3 BICYCLE RACKS

A. Bicycle Racks: Corrosion-resistant construction.

1. Basis-of-Design: CycleSafe Two-Tiered High-Density Bike Racks.
2. Capacity: **[XX][As indicated on Drawings]**.

2.4 TRASH RECEPTACLES <**INSERT DRAWING DESIGNATION**>

A. Steel Facing Surrounds: **[Steel sheet][Perforated-steel sheet][Evenly patterned, parallel flat steel straps, bars, or tubular shapes][Evenly patterned, parallel round steel rods, bars, or tubular shapes][Grid in tubular frame][Match benches]<Insert material and description>**.

B. Stainless-Steel Facing Surrounds: **[Steel sheet][Perforated-steel sheet][Evenly patterned, parallel flat steel straps, bars, or tubular shapes][Evenly patterned, parallel round steel rods, bars, or tubular shapes][Grid in tubular frame][Match benches]<Insert material and description>**.

C. Wood Facing Surrounds: **[Evenly spaced cedar slats][Teak panels][Evenly spaced teak slats] [Match benches]<Insert wood type and description>**.

D. Fiberglass Facing Surrounds: Molded fiberglass shape.

E. Plastic Facing Surrounds: **[Molded HDPE shape][Evenly spaced HDPE slats][Evenly spaced, recycled HDPE slats][Match benches]<Insert plastic type and description**>.

F. Support Frames: [**Steel**][**Galvanized steel**]; welded.

G. Trash Receptacles:

1. Receptacle Shape and Form: **[Round cylinder][Round cylinder with tapered funnel top] [Round, tapered column][Square column][Rectangular column][As indicated] <Insert shape and form>; with opening for depositing trash in [lid or top][side of lid or top]**.
2. Lids and Tops: Matching facing panels secured by cable or chain, hinged, swiveled, or permanently secured.

   a. Opening for depositing trash covered by self-closing, spring-loaded-hinged, push-in weather flap.

3. Inner Container: **[Galvanized-steel sheet][Perforated-metal][Fiberglass][Rigid plastic]** container with **[drain holes][lift-out handles]**; designed to be removable and reusable.
4. Disposable Liners: Provide receptacle designed to accommodate disposable liners.
5. Capacity: Not less than 150 L (40 Gal).

6. Service Access: Removable lid or top; inner container and disposable liner lift or slide-out for emptying; self-latching hinge.
7. Post Mount: Galvanized-steel pipe**.**

H. Steel Finish: Galvanized and **c**olor coated.

1. Color: **[Match Project Director/COR's samples][As selected by Project Director/COR from manufacturer's full range]**.

I. Stainless-Steel Finish: **[No. 6] <Insert description>**.

J. Wood Finish: **[Unfinished][Factory-applied transparent finish] [Factory-applied stain and transparent finish; Manufacturer's standard stain] [Factory-applied opaque finish] [Manufacturer's standard finish]**.

K. **[Fiberglass][HDPE]** Color: **[Match Project Director/COR's samples][As selected by Project Director/COR from manufacturer's full range]**.

L. Graphics: **[Surface-applied][Engraved][Attached brass plaque with engraved] copy, content, and style [according to manufacturer's standard][as indicated on Drawings]**.

1. Copy: Match text from Project Director/COR; dual language unless they direct otherwise.

2.5 MATERIALS

A. Steel and Iron: Free of surface blemishes and complying with the following:

1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513/A 513M, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
6. Perforated Metal: From steel sheet not less than **[1.9-mm][2.3-mm][3.0-mm]<Insert dimension>** nominal thickness; manufacturer's standard perforation pattern.

7. Expanded Metal: Carbon-steel sheets, deburred after expansion, and complying with ASTM F 1267.
8. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
9. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.

B. Stainless Steel: Free of surface blemishes and complying with the following:

1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
2. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.

3. Tubing: ASTM A 554.

C. Wood: Surfaced smooth on four sides with eased edges; kiln-dried; free of knots; solid stock, of species indicated.

1. Wood Species:

a. **[Red][Yellow]** Cedar: Select Grade or better.
b. Teak (Botanical name: “Tectona grandis”): Clear Grade.
c. **<Insert wood species>**: **<Insert grade, if applicable, and other requirements>**.

D. **[Certified Wood: Wood products shall be certified as "FSC Pure**"[or "FSC Mixed Credit"] **according to FSC STD-01-001 and FSC STD-40-004.]**

1. **[Finish: Manufacturer's standard [stain][and][transparent sealer][transparent wood-preservative treatment and sealer]<Insert treatment or finish>].**

E. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.

F. Plastic: Color-impregnated, color and UV-light-stabilized, and mold-resistant.

1. Polyethylene: Fabricated from virgin plastic HDPE resin.
2. Polyethylene with Recycled Content: Fabricated from HDPE and other resins with postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

G. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality, tamperproof, vandal and theft resistant.

H. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:

1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.27 kg/sq. m of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.0076 mm thick.
2. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

2.6 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections,

finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

E. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.7 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 STEEL AND GALVANIZED-STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.9 IRON FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.10 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run directional finishes with long dimension of each piece.
2. Directional Satin Finish: No 4.
3. Dull Satin Finish: No. 6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

D. Support Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

END OF SECTION 323305

SECTION 324003 – ANTI-CLIMB GATE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this section includes, but is not necessarily limited to, the following elements as indicated on Drawings located in and around Compound Access Control (CAC) facilities at entrance/exit gate locations to control passage of vehicles through compound perimeter:

B. Anti-climb gates for passage of vehicles, in and out of the project site, on and off the post.

1. Gate Type: **[Bi-fold][Sliding rolling][Sliding cantilever][Swing]** gate system.

2. Console/User Controls:

a. Primary:

1) Interface: **[Physical button][Touchscreen]**.
2) Location Type: **[Rack mounted][Countertop unit]**.

b. Secondary:

1) Interface: **[Physical button][Touchscreen]**.
2) Location Type: **[Rack mounted][Countertop unit]**.

C. Related Sections include the following:

1. Section 033000 "Cast-In-Place Concrete" for requirements of concrete foundations and other elements of work in and around entrance/exit gates of the perimeter.
2. Section 055005 “METAL FABRICATIONS” and 0512000 for STRUCTURAL STEEL FRAMING and metal fabrications required at entrance/exit gate locations.
3. Division 09 painting and coating Sections for field applied finish work at entrance/exit gate locations.
4. Division 26 and 27 Sections for electrical/electronic work as required.
5. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
6. Section 285115 “Security Management System Enterprise (SMSe).”
7. Section 323118 “Decorative Metal Fences and Gates” for coordination with style of other compound fencing work.

1.2 SUBMITTALS

A. General:

1. Use same names for gates in submittals as used for labels on control system; see Part 2.8 on IDENTIFICATION.

2. Submittals should be accepted by the Project Director/COR prior to procurement of associated items by Contractor; premature procurement is at the risk of Contractor.
3. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Product Data:

1. Product data for each element of work, whether purchased from other manufacturers or provided as gate fabricator's standard production. Include data substantiating that products comply with requirements of these specifications.
2. Product data for each primary material used in fabricating custom produced elements of the work; along with manufacturers' descriptive literature for standard or customized products, fabrications, assemblies, controls, buttons, monitor screens, indicator lights, devices, accessory items, and labeling used to produce work of this section. Include mechanical, electrical, and control data for operative and motorized units. Include performance charts and curves. Include complete list of equipment and materials. Identify applicable industry standards and how they apply to specific components.
3. Installation instructions.

C. Shop drawings for each type and size of customized fabrication or assembly, showing installation requirements for each element of the work of this section. Show plans, elevations, and sections at not less than 1:20 scale, and details at 1:5 scale.

1. Include dimensions of all important assemblies to confirm product will fit in the designated space with proper clearances (to include maintenance access) as applicable.
2. Include complete wiring and schematic diagrams and any other details necessary to demonstrate that the system has been coordinated and will properly function as a unit.
3. Show layout and anchorage of equipment and appurtenances, and equipment relationships to the other parts of the work (including foundation and clearances for maintenance and operation) and include sally port, barriers, and CACs as a minimum.
4. Indicate inclusion of all required accessories and features (as applicable).
5. For controls, identify project-specific information including type of controls, layout, buttons, panels, monitor screens, indicator lights and labeling. When applicable, show layouts for Primary and Secondary controls. When applicable, for screen controls on monitor screen, show graphic representation of controls and layout of each screen. For all controls, show sequence of operations to include functionality with safety devices and lock-out functionality.
6. Illustrate conformance to anti-climb design requirements identified in the Article on PERFORMANCE REQUIREMENTS.
7. Use of EU structural steel, provide a copy of the OBO approval per the ARTICLE ON MATERIALS, GENERAL REQUIREMENTS.

D. Installer Qualification Data: Submit resumes of all installers documenting that installers have installed same gate systems for a DOS project within last 5 years and the team leader has been trained by the gate manufacturer. Resume shall include at least three references (including contract information) that can provide verification that the installer has the expertise required to perform a successful installation. Installer's qualifications must be approved by the Project Director/COR with input from OBO/CFSM/SM physical security engineer.

E. **[Qualifications for Work in Corrosive Environment: Contractor shall submit evidence that confirms that gate system can operate in proposed environment and will perform consistently. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.]**

F. Manufacturer's Qualification Data: Submit resumes of manufacturers documenting conformance with requirements of Article on QUALITY ASSURANCE.

G. Durability Submittals: Submit one of the following based on Contractor's selection, and in accordance with Durability requirements in Article on PERFORMANCE REQUIREMENTS.

1. **[Test Reports: Provide independent laboratory test reports using ISO/IEC 17025 (second edition) confirming the gate system meets the performance requirement for operating under specified number of cycles.]**
2. **[Warranty: See article on CLOSEOUT SUBMITTALS.]**

1.3 INFORMATIONAL SUBMITTALS

A. General:

1. Submit Informational submittals at least four weeks prior to installation.
2. Refer to Division 01 Section on submittals for general administrative requirements.

1.4 CLOSEOUT SUBMITTALS

A. Test Reports: Upon completion and testing of the installed system, a test report shall be submitted in booklet form showing all fields tests, including component adjustments and demonstration of compliance with the specified performance criteria. Each test report shall indicate the final position controls of the primary and secondary controls within the guard booth or other locations (i.e., as-built drawings showing on which rack the controls where installed and where within the rack that they were installed).

B.

C. Training Documentation: Immediately upon completion of Operator and Supervisor training by the gate manufacturer, documentation of training shall be delivered to Project Director/COR of installation. Training shall be completed before substantial completion. Training documentation shall include:

1. The date and time of the training.
2. A list of the names of the personnel trained.

D. All closeout manuals, such as operation and maintenance manuals, are required in both printed and printable electronic formats. Along with copies required as part of Division 01 "Construction Submittals, deliver two copies of these manuals, incorporating all revisions, with system at time of commissioning. These copies shall be sent via commercial courier service to the Department

of State project director or to the cognizant post facility manager or, if directed to the Bureau of Diplomatic Security at the address below:

U.S. Department of State
Bureau of Diplomatic Security
Attn: DS/FSE/FSB – Vehicle Barrier Program Manager
SA-24 Kingstown
5800 Barclay Drive
Springfield, Virginia 22315

1. Submit copyright release for all documentation to permit reproduction and use of this material on Department of State internal automated information system networks.

E. Operation and Maintenance Manuals: Submit Operation and Maintenance data in accordance with Division 01.

1. Operation Instructions: Outline step-by-step procedures required for system startup, operation, and shutdown. Include manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.
2. Maintenance Instructions: Include routine maintenance procedures, possible break-downs and repairs, and troubleshooting guide. Include piping layout, equipment layout and simplified wiring, and control diagrams of systems as installed.

F. Spare Parts Data: Submit spare parts data for each different item of materials and equipment used. Data shall include complete list of parts and supplies, with current unit prices and source of supply.

G. **[Maintenance Plan for Corrosive Environments: Manufacturer shall develop and submit site-specific routine maintenance plan tailored to local conditions and executable by local labor force. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS for extreme corrosive environments are applicable.**

1. **Plan shall be based on a 25-year life span and show schedule for full life span.**
2. **Include routine cleaning schedule and inspection for corrosion for site specific conditions.**
3. **Provide inspector qualifications and instructions for inspecting painted coatings and instruction for repair and repaint.]**

1.5 QUALITY ASSURANCE

A. Nameplates: The anti-climb gate systems shall have the manufacturer's name, contact for service, and catalog or serial number permanently affixed to a plate securely attached to the equipment in a suitable location.

B. Label: Each operator shall bear a label indicating that the operator mechanism has been tested for full power and pressure of all hydraulic components, full stress tests of all mechanical components and electrical tests of all overload devices.

C. Verification of Dimensions: The Contractor shall become familiar with all details of the work and verify dimensions in the field as required for coordination and provide to the gate manufacturer all the applicable information.

D. Manufacturer's Qualifications: Provide anti-climb gate systems which are produced by a manufacturer who has previously produced, within the last 2 years, units of similar size and function.

E. Installer Qualifications: Engage an experienced Installer who has completed in last five years an anti-climb gate system installation similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance Team leader shall have received manufacturer training.

F. Single Source: Provide complete gate systems (leaf, controls, operator, and accessories) from a single manufacturer, or provide integrated gate system designed, assembled, and tested by a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver elements of the perimeter gate facilities to the project with assemblies prefabricated, prefinished, and equipped with devices and accessories to the greatest extent possible. Comply with Government's criteria for packaging, handling, protection, storage, and delivery. Use Manufacturer's export or General Contractor's Ocean Freight crating for shipment protection when available.

B. Store products upright in the original shipping containers, covered, ventilated and protected from all weather conditions.

1.7 WARRANTY

A. Durability: provide a 1-year comprehensive onsite material and labor warranty from Substantial Completion for any component necessary for continued operation of the gate system from substantial completion. See ARTICLE on DURABILITY requirements. Inhibiting the operation of the gate includes anything that relate to the opening/closing of gate and that this resistance requirements would generally relate to wheels, bearings, and motors.

B. Corrosion Resistance: All elements of the gate system shall be designed and constructed to resist these effects for a period of 5 years from Substantial Completion. Should corrosive damage inhibit or halt the operation of the gate system, replacement parts or new gate systems shall be shipped to the project site at no cost to the USG and installed by qualified installers provided by the manufacturer. The government at its sole discretion may opt to install the manufacturer provided replacement parts, however this will in no way void or alter the warranty.

1.8 EXTRA MATERIALS

A. Spare parts kit per manufacturer's recommended list, but as a minimum shall include:

1. PLC/controller
2. Touch screen
3. Guide rollers
4. Wheels
5. Any normal wear & tear parts.
6. Safety edge guards for gates that include edge guards.
7. Light curtain for gates that include light curtains.
8. All scheduled maintenance spare parts for up to the 200 000 cycle mark.
9. Manufacturer recommend spare part list specific to the site and gate.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide anti-climb gate systems in accordance with the OBO Zoning Code (International Zoning Code amended by OBO), ASTM F2200-20, UL325, and consistent with OBO “Physical Security Detail Handbook.” Provide all components of the gate system from a single manufacturer or provide an integrated gate system designed, assembled, and tested by a single manufacturer.

1. Provide anti-climb protection on attack side.

a. Anti-climb shall include but is not limited to hinges, light curtains, sensors, locking hasps, cross members, rails, drive rails, ornamental design, and signal lights.

B. Vehicle Control: Provide gate system capable in width of operation of obstructing vehicular traffic in 4 meter (13 ft) wide traffic lane.

C. Provide anti-climb gate system that meets all physical security requirements pertaining to fences components as described in Section 323118 “Decorative Metal Fences and Gates.”

D. Operational Speed: Provide gate and operator which travels at 300mm per second or faster.

E. Frequency of Operation: Anti-climb gate systems shall be capable of operating a minimum of 60 complete open/close cycles per hour.

F. Durability: Provide anti-climb gate systems capable of operating for 200,000 continuous cycles without failure of any component necessary for continued operation of gate. Cycle testing shall be performed in configuration where gate system itself is located in outdoor location that will expose unit to full sunlight and effects of climatic conditions at test facility (pollution, rain, snow, sleet, etc.). Anti-climb gate systems shall be capable of operating a minimum of 60 complete open/close cycles per hour.

G. Control Circuits: Design control system in such a way that when power fails, gate maintains "status quo" position. System shall fail neither secure nor safe, which prevents gate from being pushed open in event of failure.

H. Back-up and Manual Operation: Control system shall provide back-up and manual operating capability for use in event of power failure. Manual operation of gate shall be simple and without need of special tools, except for a hand crank, or knowledge and shall include a key for the cover and a manual hand-crank, which shall be located in the CAC. Gate shall be capable of being returned to secure position, in manual mode, in no more than 5 minutes.

2.2 APPROVED PRODUCTS

A. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. TyMetal Inc. Trackless Security Speed Gate/Trackless Bi-Folding Speed Gate.
2. Bavak Beveiligingsgroep B.V. electrically powered Speed Bi-Folding Speed Gate.
3. Bavak Beveiligingsgroep B.V Trackless Bi-Folding Speed Gate.
4. Ross Security Systems LLC XT-4000 Sliding Anti-Climb Gate.
5. TyMetal Inc. Embassy Steel V-Groove Gate System (sliding gate).

B. Other Anti-Climb Gate Systems may be used subject to the requirements of this specification and additional warranty requirements stated in this specification.

2.3 MATERIALS, GENERAL

A. Corrosion Resistance Performance

1. Corrosion Risk: As indicated in the Project Contract (e.g., Statement of Work), the OBO Building Code Appendix W defined OBO Atmospheric Corrosivity Level for this site is **[Low][Moderate][Extreme]**. The atmospheric corrosion risk exposure risk type for a given component shall be as defined by OBO-ICS IBC Section W101.1.2 (i.e., direct exterior, indirect exposure to exterior, and interior exposure only).
2. Corrosion Resistance Standards: Provide materials and finishes for the components in accordance with the material specifications of this Specification Section and the general material type as indicated by this article for the project-specific corrosion risk identified above or elsewhere in the Contract Documents.
3. Material Standards for Anti-Climb Gates (e.g., tubes, plates, inserts, tie rods, hardware, anchors, clips and fasteners, etc.): As applicable for the OBO Atmospheric Corrosivity Level (ACL) of site and for both direct exterior exposure and indirect exposure to the exterior:

   a. Mild Steel: hot-dipped galvanized coating; low and moderate ACL.
   b. Stainless Steel: low, moderate, and extreme ACL.

4. Finish Standards for Components: as applicable for project site: See finish requirements of this section, contract documents, and 055005 “METAL FABRICATIONS.”

B. Materials, General Requirements for Mild Steel Anti-Climb Gates

1. Hot-Rolled Steel Sheets and Strips: ASTM A 569, commercial quality, pickled and oiled, except as otherwise indicated.
2. Cold-Rolled Steel Sheets: ASTM A 366, commercial quality except as otherwise indicated.
3. Galvanized (Zinc-Coated) Steel Sheets: ASTM A 653, minimum G90 zinc coating, mill phosphatized; commercial steel except as otherwise indicated. Zinc-iron alloy-coated (galvannealed) steel sheet products are not permitted.
4. Plates, Bars, Angles, and Channels: ASTM A36 or ASTM A572
5. Hollow Structural Sections (steel tubes): ASTM A500 or ASTM A1085.
6. Inserts, Bolts Fasteners: Standard units of strengths required to endure performances; hot-dip zinc coated.
7. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers: AISI Type 316 (Alloy Group 2), complying with ASTM F593 and ASTM A594, or ASTM A193 and ASTM A194, or ASTM A320 and ASTM A194; provide compatible AISI Type 316 washers where appropriate.
8. Hot-Dip Galvanizing: All mild steel gate components must be hot-dip galvanized in accordance with ASTM A123/A123M.
9. Proposed product substitutions may be approved if they have been submitted, reviewed, and approved by OBO/PDCS/DE/CSE. Submittal shall include a copy of the pertinent material standard specifications.

C. Materials, General Requirements for Stainless Steel Anti-Climb Gates

1. Stainless Steel Plates, Sheets, and Strips: AISI Type 316, 316L, 2101 or 2205, complying with ASTM A240/A240M or ASTM A895/A895M, commercial quality.
2. Stainless Steel Bars and Shapes: AISI Type 316, 316L, 2101 or 2205, or AISI Type 316L where welding is to be performed, complying with ASTM A276/A276M or A582/A582M.
3. Stainless Steel Tubing: AISI Type 316, 316L, 2101 or 2205, complying with ASTM A1016/A1016M.
4. Stainless Steel Wire and Rod: AISI Type 316, 316L, complying with ASTM A555/A555M.
5. Stainless Steel Bolts, Hex Headed Screws, Nuts, and Washers, except where higher strengths or ductility is required, in which the Manufacturer shall submit product data for the fastener components and proposed corrosion prevention design for review and approval by OBO/PDCS/DE/CSE. See section above for stainless steel bolt requirements.
6. Stainless Steel Sheets where required for finish: AISI Type 316/316L, complying with ASTM A 240; commercial quality, **<bead blast, No. 4 directional polish or as otherwise indicated in the design documents>**.

D. Bolts and Fasteners: Where within reach of intruders working from attack-side of facilities, including working from inside sally ports, provide non-removable anti-tamper detention-style bolt/nut units (not removable by use of commonly available hand tools). Provide stainless steel washers.

E. Concrete Inserts: Furnish anchorage units to be placed in concrete substrates, of hot-dip galvanized cast-iron/malleable-iron body, design/type as indicated; ASTM A 153 zinc coating, ASTM A 47 casting. In addition to any restrictions or requirements indicated on the Construction Drawings, post-installed anchor systems proposed by the Contractor's delegated design shall each have ICC-ES Evaluation Report indicating conformance with current applicable ICC-ES

Acceptance Criteria including, but not limited to, for cracked concrete for concrete substrates, seismic applications, and for the use in the specific substrate type and characteristics intended. Shop drawings and field sketches shall clearly indicate critical embedment, spacing, and edge distance requirements and placement tolerances determined by the design.

F. Setting/Anchoring Cement: Provide non-shrinking, non-staining, hydraulic-controlled expansion-type cementitious compound; factory prepackaged for mixing with water at project for a pourable and trowel-able mix, recommended by manufacturer for exterior exposure (ASTM C 109).

G. <Aluminum Extrusions: ASTM B 221, Alloy 6005, Temper T5 or T6; sizes, shapes, and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated. Aluminum is acceptable for panels but is generally not acceptable for structural posts and rails; but in all cases the use of aluminum requires the approval of OBO/CFSM/SM/SCD/SEB.>

H. Fabricated steel: Provide galvanized coating including chemical cleaning complying with SSPC-SP1, followed by pickling treatment complying with SSPC-SP8, followed by hot-dip zinc coating complying with ASTM A 123. Provide prime coat recommended by finish coat manufacturer consisting of a hot-phosphate solution treatment, followed by a chrome-acid rinse, and followed by a dip-metal primer coating which is oven dried for 30 minutes at 149 degrees C (300 F). Provide special finish coating of polyester or acrylic enamel, electrostatically applied and baked on in accordance with coating manufacturer's instructions to dry film thickness of 1.5 mils (0.038 mm); or a two-coat powder coat finish if approved by OBO/PDCS/DE/AD, color as indicated or, if not otherwise indicated, as selected by COR from submission of available colors. Finish steel accessories with same or equivalent finish.

I. Provide touch-up paint with each painted gate.

J. Gate operators shall conform to UL325 and be listed by a testing laboratory.

K. Use high speed gate operators on UL 325, Class III and Class IV installations only.

2.4 GATE FABRICATION

A. General: Fabricate anti-climb gates at the factory to the greatest extent possible, including interfacing, supporting, and anchorage provisions as required for installation. Fabricate to comply with indicated performance requirements. Disassemble only to the extent required for handling, delivery, and installation. Provide anti-climb gate systems with all components designed and assembled by the gate manufacturer. The entire gate system shall be a complete kit warrantied by the gate manufacturer.

1. Factory Welding: To improve corrosion resistance, all welding should be factory welded prior to paint or other finishes. Field welding is prohibited, alternative assembly methods shall be used.
2. Surface Preparation at All Welds to Stainless Steel: Remove oxides, carbon precipitation, and weld splatter at or around welded joints and passivate surfaces in accordance with ASTM A380 and ASTM A967.

B. Fabricate gates as follow:

1. Use only electric, hydraulic, or pneumatic drive systems for anti-climb gate systems.
2. Provide 24 VDC, battery backed-up control circuitry.
3. Provide system which retains gate in current position when there is a power failure.
4. Provide a system for back-up system for the control systems for manual operation of gate when there is a power failure.
5. Hydraulic Lines: Where power and hydraulic lines are required and are below grade, protect lines with rigid electrical conduit. Where temperatures will exceed 38 degrees C (100 degrees F) for extended periods of time, provide a cooling unit for the hydraulic fluid as recommended by the manufacturer.
6. Provide mechanical disconnect switch in secure location.
7. Fabricate gate panels and supporting elements and appurtenances so that a 130 mm diameter sphere cannot pass through any portion of the gate panel or any location where the gate panel interfaces with the surrounding construction (on the attack side) including where the gate panel meets the ground.
8. Fabricate units with member sizes, shapes, and spacings as shown, and with overall dimensions of each unit as shown. Provide vehicle gates with anti-climb protection and UL325 and ASTM F2200 compliance.
9. Ease exposed edges of fabricated metal elements to approximately 0.8mm (1/32-inch) radius, prior to finishing.
10. Avoid the use of bolts and screws exposed and accessible from the exterior (attack side) of fabricated units. Where unavoidable, provide non-removable (with ordinary hand tools) type fasteners in the assembly.
11. Provide provision locking device for each (closed) gate, located on inside (secure side) of fence except where indicated as exterior.

    a. Design for Locking Device: Door assembly shall be capable of being secured by one of the following Government-Furnished Government-Installed lock types:
    b. Padlock with minimum 10 mm (3/8 inch) shackle diameter and shackle clearance of 45 mm or less.
    c. Lock accepting Medeco keyed six point interchangeable core.

12. Design load bearing gate to be easily serviceable and to withstand dead/live load with minimum safety factor of 2. For sliding gates, provide minimum of two, tandem (truck style) V-wheel assemblies per gate leaf, 150 mm diameter steel machined wheels with sealed roller bearings and pivoting brackets, 2200 kilogram minimum capacity.
13. Guide or support wheels should utilize nylon or synthetic roller and sealed maintenance free bearings and be capable of up and down movement, to compensate for uneven tracks, that provides constant engagement with the gate leaf as it travels.
14. V-track should be poured in place, level, plumb and straight and run the continuous length of both full open and full closed gate travel.
15. **[Ice Melting: Provide in-ground ice/snow melting capability in sallyport and sidewalks surrounding CACs when located in snow/ice environment.]**
16. Provide lane indicator lights, red and green, to indicate the direction of traffic when more than one lane of traffic exists in the sallyport.
17. Provide physical stop at both ends of the gate assembly.
18. Provide limit switches.

19. Provide “open gate annunciator”, voice annunciator that signals that the gate has been left open after 60 seconds in the open position. For perimeter gates the annunciator shall annunciate; “the perimeter gate is open.” For compound side sallyport gates, the annunciator shall annunciate: “the compound gate is open.”

2.5 GATE OPERATOR

A. General: Design sliding gate operator for continuous duty in high-cycle applications and require low maintenance. Operation shall be by means of a metal rail passing between a pair of solid metal wheels with polyurethane treads. Operator motors shall be hydraulic, geroller type, and system shall not include belts, pulleys, roller chains or sprockets to transfer power from operator to gate panel, or approved equal. The operator shall be capable of actuating gates up to 5 meters in overall length. Slide and bifold gate operators shall feature a ‘soft start’ and ‘soft stop’ to minimize shock loads to the gate and maximize hardware life.

1. The housing cover shall be able to accept a lock. All operator cover locks are to be keyed alike.
2. Chassis: 6mm (1/4") steel base plate and 2.66mm (12 Ga.) sides and back welded and ground smooth.
3. The housing and chassis shall be galvanized per ASTM 123M for Low/Moderate ACL environments and for Extreme ACL environments ASTM 316L.
4. Electrical enclosure: Oversized, metal, with hinged lid gasketed for protection from intrusion of foreign objects and providing ample space for the addition of accessories.
5. Hydraulic fluid: High performance type with viscosity index greater than 375 and temperature range -40 C to 75 C degrees (-40 F to 175 F).
6. All components shall have overload protection.
7. Control circuit: 24VDC.
8. Built-in “warn before operate” system.
9. User relay outputs options, “gate open 60 sec” alert and “gate operator tamper switch” for connection to user control panels.
10. Display for system configuration and reporting of control status.
11. Heating and Cooling System: Provide heating and cooling system per manufacturers' recommendations.
12. Manual Operation: Provide gate operating system with capability of disengaging the drive mechanism without the use of tools, so that the gate can be manually operated. The release mechanism must not be accessible from the threat side of the gate. The gate panel shall be securely locked in place any time the drive assembly is engaged.
13. Gate operation systems which feature any significant components housed below grade shall include a sump pump.
14. Provide gate operator with emergency close feature to override obstruction devices when in Emergency mode.
15. Provide power-off lock that mechanically restricts or interrupts the movement of the gate in the event of a power loss, resulting in the gate being inherently locked.

2.6 TOUCH SCREEN CONTROL SYSTEMS

A. If selected for use on the project, provide touch screen control systems capable of the operations identified in this Article.

B. Gate Control: Provide fabricated perimeter gates that are capable of being controlled remotely from the Primary (typically located in Post 1) and Secondary control panel (typically located within the CAC guard booth). Provide override capabilities from the Primary control panel (typically located within MSG post 1).

1. Provide units capable of being mounted in 480 mm (19”) racks or on desktop.

a. If selected for use on the project, provide rack mounted controls in accordance with Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks.
b. On dual or multiple lane sally ports or installations with more than two gates at a single CAC, provide a custom panel that consolidates controls (separate controls and EFOs required for each gate; however, open gate annunciator may be combined per sally port).

2. Provide systems that have programming systems that can be adapted with updated ladder logic programming from manufacturer. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).

C. Provide a Secondary control panel with the following:

1. Emergency Operation (EFO) button for each gate location (toggle switch with flip cover) (located above touchscreen and not part of the touchscreen). EFO switch may be located on the side with the approval of OBO/CSM/SM/SCD/SEB.
2. Open button
3. Close button
4. Stop button
5. Gate status indicator on the screen. (i.e., open, close)

a. Visual indication light when gate is in open position.
b. Visual indication light when gate is in closed position.
c. Audio and visual indication signal when gate is in open position for more than 60 seconds.

6. Audible annunciator, which is automatically activated when gate remains in the open position in excess of adjustable time period with adjustment capability up to 60 seconds.
7. The emergency switch or switches for the Secondary control must not be equipped with reset capability.
8. Provide either rack mounted (default standard) or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate design and selection with architectural and technical security systems design.

a. Gate controls are considered primary pieces of equipment and shall be placed so that the secondary operator can see the gate and the controls at the same time and for the primary operator, the CCTV and controls and located in his primary point of view.

D. Provide a Primary control panel with the following:

1. Emergency Operation (EFO) button for each gate location (toggle switch with flip cover) (located above touchscreen and not part of the touchscreen)
2. Open button
3. Close button
4. Stop button
5. Gate status indicator on the screen. (i.e., open, close).

   a. Visual indication light when gate is in open position.
   b. Visual indication light when gate is in closed position.
   c. Audio and visual (flashing or other) indication signal when gate is in open position for more than 60 seconds.

6. Audible annunciator, which is automatically activated when gate remains in the open position in excess of adjustable time period with adjustment capability up to 60 seconds.
7. EFO reset button
8. Gate interlock override button when used in a CAC sallyport location.

E. Provide Emergency Fast Operation (EFO) control system that overrides all safety and obstruction components of gates when in emergency modes. Provide EFO speed of at less than 8 seconds for 3.7-m wide opening.

F. Provide an “emergency stop” button at both control panels. Stop or emergency stop button must immediately stop the gate independently of the gate opening or closing.

G. Primary and Secondary panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections).

H. Interlocking functions: Provide control systems capable of locking out sallyport gate open operation when vehicle gate located on perimeter side of sallyport is in open position. Provide two stage button override control of interlocking override function at only the Primary control panel.

I. Monitor screens: Provide monitors with minimum 175 millimeter (7 inch) screen size. Monitor screens shall provide clear readable views of controls in bright sunlight and glare conditions. Monitors shall be Thin Film Transistor (TFT) Liquid Chrystal Display (LCD) type, high contrast color screens, 1280 x1024 pixels. Each monitor shall graphically depict each gate being controlled, at top of the screenso that gate operator can view the gate operation via screen. Directly below view of the gate, centered under this view, provide label of which gate is being controlled (e.g., “Main CAC Exterior Sallyport Gate”). Text of label shall be clear and easily readable with minimum 10mm, Times New Roman Bold. Directly to left of label, locate gate “CLOSED” button. CLOSED button shall be minimum of 25 mm in diameter and labeled below button “CLOSED” with clear and easily readable, minimum 15mm, Times New Roman Bold. Directly

to right of label locate gate "OPEN" button. OPEN button shall be minimum of 25 mm in diameter and labeled below button "OPEN" with clear and easily readable, minimum 15mm, Times New Roman Bold.

J. Provide an infrared vertical safety light curtain that provides continuous coverage not less than 1067mm (42 inches) high at each side of the gate (attack and secure). Mount 125mm (5 inches) above finish grade. Flush or surface mount so that equipment does not project more than 45mm (1.75 inches). Controls must be configured to stop gate when plane of light curtain is broken, except when EFO system is engaged.

K. Traffic lane indicator light controls (if applicable, multi lane sallyport only).

L. Controls must result in an installation which complies with the operational testing requirements identified in Article on FIELD TESTING.

M. System Processing Control Unit:

1. Self-diagnostic systems: Provide gate control systems capable of self diagnosis. Minimum features required are:

   a. Audit Trail: Provide audit trail of open, close, EFO, interlock and reset functions of gate that is easily user interpreted.
   b. Cycle counter: Provide cycle counter that records each cycle of gate. Provide gate cycle counter in gate and in control system. Cycle counter in gate unit shall be readily visible to maintenance staff monitoring gate.
   c. Lifecycle Function: Lifecycle function that alerts maintenance staff of required or upcoming necessary maintenance.
   d. Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 "Security Management System Enterprise (SMSe). Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System shall require user ID and Password for access to secure connection.
   e. Troubleshooting: Provide systems that have troubleshooting function. Troubleshooting function shall contain standardized code system or language that is consistent for each of manufacturer's gate systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.
   f. Low oil level monitor: Provide monitor that warns gate operator when oil level in unit is low.

2. Standardized controllers: Provide controllers capable of operating up to two gates per controller unit.
3. Equipment and components: Provide only programmable logic controllers (PLCs) and other components that are compatible with RS232, ethernet CAT 5/6 technologies, or fiber optic ethernet.
4. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting the unit or inadvertently triggering the system.

5. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.7 PUSH BUTTON CONTROL SYSTEMS

A. Touch screen controls are the default system and if push button control system is used, it requires OBO/CFSM/SM approval. If approved, provide push button control systems capable of the operations identified in this Article.

B. Gate Control: Provide fabricated anti-climb gates that are capable of being controlled remotely from the secondary control panel (typically located within the CAC guard booth). Provide override capabilities from the Primary control panel (typically located within MSG post 1).

1. Provide units capable of being mounted in 480mm (19”) racks or on desktop. If selected for use on the project, provide rack mounted controls per; Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. On dual or multiple lane sally ports or installations with more than two gates provide a custom panel that consolidates controls (separate controls and EFO’s required for each gate; however, open gate annunciator may be combined per sally port).
2. Provide systems that have programming systems that can be adapted by end user with updated ladder logic programming from manufacturer. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).

C. Provide a secondary control panel with the following:

1. Emergency Operation (EFO) button for each gate location (toggle switch with flip cover)
2. Panel power indicator light: on when panel is operational and controls operational; off when power or control is removed from primary panel
3. Open button (green) minimum 22mm diameter
4. Close button (red) minimum 22mm diameter
5. Stop button (black) minimum 22mm diameter
6. Gate status indicator light. (i.e., open, close)

    a. Visual indication light when gate is in open position.
    b. Visual indication light when gate is in closed position.
    c. Audio (recorded voice) and visual indication signal when gate is in open position for more than 60 seconds.

7. Audible annunciator, which is automatically activated when gate remains in the open position in excess of adjustable time period, with adjustment capability up to 60 seconds.
8. The emergency switch or switches for the secondary control must not be equipped with reset capability.
9. Provide either rack mounted or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate design and selection with architectural and technical security systems design.

D. Provide a Primary control panel with the following:

1. Emergency Operation (EFO) button for each gate location (toggle switch with flip cover)
2. Open button (green) minimum 22mm diameter
3. Close button (red) minimum 22mm diameter
4. Stop button (black) minimum 22mm diameter
5. Gate status indicator light. (i.e., open, close)

    a. Visual indication light when gate is in open position.
    b. Visual indication light when gate is in closed position.
    c. Audio and visual indication signal when gate is in open position for more than 60 seconds.

6. Audible annunciator, which is automatically activated when gate remains in the open position in excess of adjustable time period, with adjustment capability up to 60 seconds.
7. EFO reset button (black) minimum 22mm diameter.
8. When part of a sallyport configuration, provide Interlock tun switch (on/off): when on a gate cannot be opened unless the other gate is completely closed.
9. Capable of overriding and disabling the secondary panel with turn switch (on/off)
10. Provide either rack mounted or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate design and selection with architectural and technical security systems design.

E. Provide Emergency Fast Operation (EFO) control system that overrides all safety and obstruction components of gate when in emergency modes. Provide EFO speed in accordance with the Part 2 Article on PERFORMANCE REQUIREMENTS.

F. Primary and secondary control panels shall not require keys for operation.

G. Primary and secondary panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections).

H. System processing control unit:

1. Self-diagnostic systems: Provide gate control systems capable of self-diagnosis. Minimum features required are:

    a. Audit Trail: Provide audit trail of up, down, EFO, interlock and reset functions of gate that is easily user interpreted.
    b. Cycle counter: Provide cycle counter that records each cycle of gate. Provide gate cycle counter in gate and in control system. Cycle counter in gate unit shall be readily visible to maintenance staff monitoring gate.
    c. Lifecycle Function: Lifecycle function that alerts maintenance staff of required or upcoming necessary maintenance.
    d. Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 “Security Management System Enterprise (SMSe).” Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System shall require user ID and Password for access to secure connection.

e. Troubleshooting: Provide systems that have troubleshooting function. Troubleshooting function shall contain standardized code system or language that is consistent for each of manufacturer's gate systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.
f. Pressure monitoring meter: Provide pressure monitoring meter on hydraulic and pneumatic units.
g. Low oil level monitor: Provide monitor that warns gate operator when oil level in unit is low.

2. Equipment and components: Provide only programmable logic controllers (PLCs) and other components that are compatible with RS232, ethernet CAT5/6 technologies, or fiber optic ethernet
3. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting unit or inadvertently triggering system.
4. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.8 IDENTIFICATION

A. Provide product identity by letter, name, or number (i.e. street name, MCAC, SCAC, etc.) and by location within the sallyport (i.e. compound side, street or plaza) by which controls may be uniformly labeled for local (CAC) and remote (Post 1). Coordinate with OBO construction management or the COR for final approval of names.

2.9 ACCESSORIES, AS APPLICABLE TO THE TYPE OF GATE:

A. Gate operator tamper switch.

B. Remote control panel with annunciator, override and reset.

C. Emergency Manual Operation: Provide hand crank to allow gate to be opened manually in event of prolonged power interruption.

D. Emergency fast operation.

E. Low fluid level switch.

F. Export packaging.

G. Electrical disconnect at the hydraulic unit.

H. Uninterrupted Power Supply (UPS) for Primary and Secondary control panels.

I. Lock for operator cover.

J. Safety light curtains.

K. **[Provide Power unit enclosure where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS. The steel enclosure shall be minimum of 2 mm thick steel and provided with DS approved padlock. Enclosure may be custom fabricated if not a standard accessory from power unit manufacturer.]**

L. **[Heating unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]**

M. **[Cooling unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]**

PART 3 - EXECUTION

3.1 EXAMINATION, COORDINATION, PREPARATION

A. General: Examine substrate work, being prepared as work of other sections, for the anchorage and support of perimeter gate facilities of this section. Deliver anchorage inserts, sleeves, and other elements to be cast in concrete work, prior to time scheduled for placement of concrete. Furnish instructions, setting diagrams, templates, and/or other information for elements to be installed as work of other sections. Set posts, frames and similar elements plumb, level and true to line and location; and support adequately during placement of concrete.

B. Examine prefabricated units, and preparations made and to be made as work of other Sections, and confirm that interfaces and support of work of this section will achieve performances and align within installation tolerances.

C. Coordinate installation of gate facilities with installation of related work to ensure optimum sequencing of interfaces.

3.2 INSTALLATION

A. Comply with manufacturer's instructions for the handling, protection, assembly, installation, anchorage, and other required interface connections of gate with other work. Set level and plumb, true to line and location. Anchor to develop full-strength resistances against attacks and forced-entry attempts.

B. Install exposed gate hardware, track, and devices with nonremovable or anti-tamper detention-style fasteners, where exposed to attack side. Assemble gate operating equipment and control system for smooth, secure gate movements, with ground-set items anchored in concrete supports. Comply with applicable installation provisions of ASTM F 1184, UL325 and ASTM F2200. For Bi-folding gates comply with UL325 and ASTM F2200.

C. Follow all UL-325 and ASTM F2200 safety standards and ensure that during installation and maintenance that a safety zone is established as well as fall protection and entrapment protection.

D. Installation of control panels:

1. When control panels are installed in racks, they shall be installed adjacent to anti-ram barrier controls when part of sallyport configuration.
2. Control panels shall be located high enough in rack that allows easy access without having to bend over. Secondary panels shall be installed so visual of gate can be maintained while using controls.
3. If touch screen is used, it must be located high enough in rack or on sloped section so that screen can be easily seen.
4. When Primary panel is located remotely, controls shall be installed so video monitor of gate can be seen while controlling gate.

3.3 TESTING AND ADJUSTING

A. Test gate operator through ten full cycles and adjust for operation without binding, scraping, or uneven motion. Test limit switches for proper 'at rest' gate position. Factory representative is required to be named and/or sign the Certificate of Compliance.

B. Test operate each gate facility operational unit through repeated cycles of operation; and demonstrate operation, controls, safety devices, signals, and other features to Project Director/COR. Provide adjustments as requested to comply with requirements and intended cycles of use and operation.

C. Instructions for testing anti-climb gate systems from Secondary Control Panel:

1. Test function of traffic lane indicator lights if applicable.
2. Cycle gates Open and Close and listen for binding or rubbing.
3. Check light curtain for function, reverse, or stop of gate while going closed.
4. Check open gate annunciator. Leave the gate in the open position. After a preset period (no more than one minute) an alarm will sound from the Secondary unit and from the Primary Control Panel. This annunciator can be set in gate operator panel.
5. Test the emergency close function. Be sure there is no vehicle or individual standing near the gate and have a safety person control the site. Check to make sure all safety functions are disabled while the gate is operating in the emergency mode.

    a. Activate the emergency close, from the open position - the gate should close quickly. Record the time (should be 8 seconds or less). The Secondary controller should now be inoperative and will have to be reset from the Primary controller in MSG Post I.

6. Test that the gate locks when the power is cut and the back-up system is depleted.
7. Test that the gates and controls will work under generator power from Secondary control station.
8. Cut all power to the hydraulic pump or electrical supply and test that the gate can be operated manually.

D. Instructions for testing anti-climb gate systems from Primary Control Panel

1. Test function of traffic lane indicator lights if applicable.
2. Cycle gates Open and Close while listening for binding or rubbing.
3. Check light curtain for function, reverse, or stop of gate while going close.

4. Check open gate annunciator. Leave gate in open position. After preset period (no more than one minute), an alarm shall sound from Secondary unit and from Primary control panels. This annunciator can be set in gate operator panel.
5. Test emergency close function; ensure that no vehicles or individuals are standing near gate, and have safety person control site. Ensure that all safety functions are disabled while gate is operating in emergency mode. Activate emergency close from open position; gate should close quickly. Record time; an acceptable closing time is 8 seconds or less. Secondary controller should now be inoperative and will have to be reset from Primary controller in MSG Post 1. Confirm that Secondary panel is completely disabled. Then confirm that 'reset' button in Primary Control Panel reactivates Secondary Control Panel buttons and switches.
6. Test that gate locks when power is cut and back-up system is depleted.
7. Test that gates and controls work under generator power from Primary Control station.

3.4 CLEANING AND FINISHING

A. Clean exposed surfaces of gate facilities, including primed surfaces and finished surfaces, exercising care to avoid damage to finishes; touch up minor blemishes in finished surfaces.

B. Refer to Division 09 Sections on painting and high-performance coatings for application of field-applied finish coatings over shop-applied primer coatings; not work of this section.

1. **[On a case-by-case basis, a two coat powder coat system may be approved as a substitution with approval of OBO/CSM/SM/SCD and OBO/PDCS/DE/AD.]**

3.5 MANUFACTURER'S SERVICE

A. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment. A commissioning agent is not an approved substitution for the manufacturer's representative.

3.6 TRAINING

A. Operator Training: Manufacturers' representative shall provide initial Operator training to Local Guard Force (LGF) personnel. A commissioning agent or general gate technician is not an approved substitution for the manufacturer's representative. Training shall be delivered at post of installation within one business day following commissioning of new system. Initial Operator training shall include:

1. Overview of system.
2. Essential controls and displays.
3. Safety precautions.

B. Supervisor Training: Manufacturer's representative shall provide initial Supervisor training for Regional Security Officer (RSO) or designated representative, LGF supervisor, and others as

identified by RSO. This training shall be delivered at post of installation within one business day following commissioning of the new system. Initial Supervisor training shall include:

1. Overview of system.
2. Understanding of system's purpose and capabilities.
3. Essential controls and displays.
4. Safety precautions.

C. Maintenance Training: Manufacturer or representative shall provide Maintenance training, including MANUFACTURER'S CERTIFICATION TRAINING to level of "Factory Authorized Technician" status at manufacturer's facility for the following personnel:

1. Two instructional personnel from DS/SECD/TTB.
2. One instructional designer from DS/TPS/ISM.
3. One DS/C/ST subject matter expert (SME).
4. One person from OBO/CFSM/SM/SCD/TSB.

D. Manufacturer shall provide no less than two additional spaces per each Maintenance training class and/or training at their manufacturing facility for other DOS-designated personnel. This training shall encompass all aspects of operations, maintenance, safety, and repair.

E. Maintenance training shall enable personnel listed in this section to perform routine maintenance and inspection requirements in compliance with manufacturers' requirements.

F. Maintenance or repair that is not considered routine shall not be attempted without consultation with manufacturer and not by other than factory technicians or post personnel adequately trained for all safety and procedural precautions. Prepare and coordinate planned activities with post Security and Facility Maintenance management.

G. Manufacturer shall make available annual refresher or re-certification Maintenance training for personnel identified in Paragraph on "Maintenance Training" above.

H. System upgrades that require more than four hours for operator accommodation shall require operator and supervisor training as specified in of this specification as for new system.

END OF SECTION 324003

Certificate of Compliance

Anti-Climb Gate Systems

Gate Number_____
(Per Construction Documents)

Manufacturer Name and Model Number_____

Serial Number_____

The contractor shall complete the Certificates of Compliance in full prior to acceptance of the Anti-Climb Gates Systems by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager.

		Installer Team Lead Initials / Date	Contractor QC Manager Initials/Date
1	Employees performing the installation meet the specified training and experience qualifications.		
2	Safety meeting was held prior to installation of gates to include fall over protection, protection when working in an entrapment zone and establishing safety zones.		
3	Identification tags have been provided and installed with accurate product and manufacture information		
4	Verify that that there any entrapment zones include an IR, photo eye or other safety sensor.		
5	When Recessed base is used, tracked base or bi-fold base must have unobstructed drainage piping and/or drainage sump pump connected and operational.		
6	Prior to Cycle Testing, all gate system components and controls are fully installed and integrated • Vehicle safety and traffic signal light devices integrated into the post or freestanding • Audible alarms • Secondary control panel (CAC Guard Booth) • Primary override control panel (Post 1 Guard Booth) • Main electrical power/ Backup electrical power		
	Cycle Testing (Minimum 3 Full Cycle Tests)		
7	**Testing procedure from Secondary Control Panel**: 1. Exercise open and close and listen for binding or rubbing. (Minimum open/closed speed 300 mm per second)		
8	2. Check stop & go lights.		

		Installer Team Lead Initials / Date	Contractor QC Manager Initials/Date
9	3. Check open alarm. Leave the gate in the open position. After a preset period (no more than 60 seconds) an alarm will sound from the Secondary unit and from the Primary.		
10	4. Test photo eye, IR, light curtain and all safety sensors, except the primary sensor on the motor that detects it has encountered an immovable object. Test motor sensor only if instructions are provided by the gate manufacturer. a. Open the gate and place a vehicle, or suitable object, so that it is in the path of the light curtain, IR or other safety sensor but not so that it will be struck by the gate. Attempt to close the gate- it should not close. If safety system is tied to an adjacent gate sharing light curtains, test light curtains for operability. Test edge sensors separately using an object but being careful not to get struck.		
11	5. Test the emergency close function. Be sure there is no vehicle or individual standing on or immediately next to the gate and have a safety person control the site. a. PART I: Activate the emergency close, from the open position - the gate should close. b. PART II: Now park a vehicle, or use a suitable object so that it engages the safety detection devices. Then follow PART I sequence - The emergency close function should now override the safety loop or light curtain – the gate should close.		
12	6. Cut all power to and test that the gates can be operated the required minimum number of cycles using the back-up system. Record the number of cycles.		
13	7. Test that the gate will work under generator power.		
14	8. Cut all power and test that the gate can be operated full cycle of the unit under manual function as prescribed within the specification.		
	Testing procedure from Primary Control Panel		

		Installer Team Lead Initials / Date	Contractor QC Manager Initials/Date
15	1. Check same Secondary Control Panel functions 7 thru 13 above from the Primary Control Panel.		
16	2. Check reset function from Primary Control Panel.		
17	Check that the gates interlocking is working and the override as well.		
	Contractor's QC Manager Printed Name _____ Signature _____ Initials _____		
		Contractor's QC Manager Printed Name _____ Signature _____ Initials _____	

Noted Variances:

_____
_____
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_____

DOS Approving official approval/rejection/further action indicated for each variance.

_____
_____
_____
_____
_____
_____

[1, 2]DOS Approving Official: _____Date:_____
Office:_____ Name:_____ Position:_____

[1]DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2]Certificate of Compliance is required to be included in the close out submittal.

SECTION 324004 – ANTI-RAM GATE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this section includes, but is not necessarily limited to, the following elements located in and around Compound Access Control (CAC) facilities at entrance/exit gate locations:

1. Anti-ram gates for passage of vehicles, in and out of the project site, on and off the post.

B. Related Sections include the following:

1. Section 033000 "Cast-in-Place Concrete" for requirements of concrete foundations and other elements of work in and around entrance/exit gates of the perimeter.
2. Section 055005 “Metal Fabrications” for structural steel and metal fabrications required at entrance/exit gate locations.
3. Division 09 Sections for field applied finish work at entrance/exit gate locations.
4. Division 26 Sections for electrical/electronic work as required.
5. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
6. Section 285115 “Security Management System Enterprise (SMSe).”
7. Section 323118 “Decorative Metal Fences and Gates” for coordination with style of other compound fencing work.

1.2 SUBMITTALS

A. General: All manuals, including operator, maintenance, and repair manuals are required in both printed and printable electronic formats. Along with copies required as part of Division 01 “Construction Submittals, deliver two copies of these manuals, incorporating all revisions, with system at time of commissioning. These copies shall be sent via commercial courier service to:

U.S. Department of State
Bureau of Diplomatic Security
Attn: DS/FSE/FSB – Vehicle Barrier Program Manager
SA-24 Kingstown
5800 Barclay Drive
Springfield, Virginia 22315

1. Submit copyright release for all documentation to permit reproduction and use of this material on Department of State internal automated information system networks.

B. Product data for each primary material used in fabricating custom produced elements of the work; along with manufacturers’ descriptive literature for standard or customized products, fabrications, assemblies, devices, and accessory items used to produce work of this section. Include mechanical, electrical, and control data for operative and motorized units, along with spare parts listing and maintenance manuals. Include performance charts and curves. Include complete list

of equipment and materials. Identify applicable industry standards and how they apply to specific components. Include installation instructions.

C. Shop drawings for each type and size of customized fabrication or assembly, showing installation requirements for each element of the work of this section. Show plans, elevations, and sections at not less than 1:20 scale, and details at 1:5 scale. Shop drawings shall contain complete wiring and schematic diagrams; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationships to the other parts of the work including foundation and clearances for maintenance and operation. Shop drawings must also indicate all applicable accessories and features that are to be provided.

D. Manufacturer's Certification: Documentation that system is tested and certified by ASTM in accordance with Article on QUALITY ASSURANCE. Certified performance compliance documentation, to the extent elements are indicated with specific performance requirements; including actual crash test reports, equivalency certifications, design/analysis calculations, and similar data suitable for the demonstration of performance achievement.

E. Previous Successful Use: Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle gate installed.

F. Test Reports: Upon completion and testing of the installed system, a test report shall be submitted in booklet form showing all fields tests, including component adjustments and demonstration of compliance with the specified performance criteria. Each test report shall indicate the final position controls.

G. [Maintenance Plan for Corrosive Environments: The manufacturer shall develop and submit a site-specific routine maintenance plan tailored to local conditions and executable by the local labor force. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.]

H. [Qualifications for Work in Corrosive Environment: The contractor shall submit evidence that confirms that the gate system can and will operate in the proposed environment and will perform consistently. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.]

I. Operation and Maintenance Manuals: Submit Operation and Maintenance data in accordance with Division 01.

1. Operation instructions shall outline the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacture's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.
2. Maintenance instructions shall include routine maintenance procedures, possible break-downs and repairs, and troubleshooting guide. The instructions shall include piping layout, equipment layout and simplified wiring, and control diagrams of the systems as installed.

J. Spare Parts Data: After approval of the shop drawings the Contractor shall submit spare parts data for each different item of materials and equipment used. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

K. Installer qualification data: Submit resumes of all installers documenting the installers have installed the same gate systems for a DOS project within the last 5 years. The resume must include at least 3 references (including contract information) that can provide verification that the installer has the expertise required to perform a successful installation. The installer's qualifications must be approved by the Project Director/COR with input from OBO/CFSM/SM physical security engineer.

L. Durability Submittals: Submit one of the following based on Contractor's selection, and in accordance with Durability requirements in Article on PERFORMANCE REQUIREMENTS.

1. [Test Reports: Provide independent laboratory test reports using ISO/IEC 17025 (second edition) confirming the gate system meets the performance requirement for operating under specified number of cycles.]
2. [Warranty: Provide warranty for operability.]

M. Training Documentation: Immediately upon completion of Operator and Supervisor training, documentation of training shall be delivered to Project Director/COR of installation. Training documentation shall include:

1. The date and time of the training.
2. A list of the names of the personnel trained.

1.3 QUALITY ASSURANCE

A. Nameplates: The anti-ram gate systems shall have the manufacturer's name, contact for service, and catalog or serial number permanently affixed to a plate securely attached to the equipment in a suitable location.

B. Verification of Dimensions: The Contractor shall become familiar with all details of the work, and verify dimensions in the field as required for coordination.

C. Performance Evaluation: The gate system shall comply with ASTM F 2656, Standard Test Method for Vehicle Crash Testing of Perimeter Barriers, latest revision. Conform to vehicle resistance standards identified in Article on PERFORMANCE REQUIREMENTS."

D. Installer Qualifications: Engage experienced Installer who has completed in last five years anti-ram gate system installation similar in material, design, and extent to that indicated for this Project and with record of successful in-service performance.

E. Label: Each operator shall bear a label indicating that the operator mechanism has been tested for full power and pressure of all hydraulic components, full stress tests of all mechanical components and electrical tests of all overload devices.

F. Source Limitations for Gate Systems: Provide complete gate system and all components (leaf, controls, operator, and accessories) of gate system from single manufacturer or provide integrated gate system designed, assembled, and tested by single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver elements of the perimeter gate facilities to the project with assemblies prefabricated, prefinished, and equipped with devices and accessories to the greatest extent possible. Comply with Government's criteria for packaging, handling, protection, storage, and delivery. Use Manufacturer's export or Ocean Freight crating for shipment protection when available.

B. Store products upright in the original shipping containers, covered, ventilated, and protected from all weather conditions.

1.5 [WARRANTY

A. Special Project Warranty:

1. [Durability: In lieu of testing of the gate system the manufacturer may provide a 5-year comprehensive on-site material and labor warranty from Substantial Completion for any component necessary for continued operation of the gate system.]

2. [Corrosion Resistance: All elements of the gate system shall be designed and constructed to resist these effects for a period of 5 years from Substantial Completion. Should corrosive damage inhibit or halt the operation of the gate system replacement parts or new gate systems shall be shipped to the project site (at no cost to the USG) and installed by qualified installers provided by the manufacturer. The government at its sole discretion may opt to install the manufacturer provided replacement parts, however this will in no way void or alter the warranty.]

1.6 EXTRA MATERIALS

A. Spare parts kit per manufacturer's recommended list.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide anti-ram rolling or cantilever gate systems in accordance with ASTM F2656 and the OBO Zoning Code (International Zoning Code as amended by OBO), UL325, and consistent with OBO "Physical Security Detail Handbook."

B. Vehicle Resistance: Provide anti-ram gate systems which are produced by manufacturers who have previously produced, within the last two years, units of similar security attack resistance of equivalent size and resistance ratings, and which have been certified by the Bureau of Diplomatic

Security (DS). Required performance is for a test rating of **[M50] [M40] [M30]** per project location design via speed approach calculations with maximum vehicle penetration of P1. Provide gate capable, in width of operation, of obstructing vehicular traffic in a 4 meter (13 ft) wide traffic lane.

C. Operational Speed: Provide gate and operator which travel at 300mm per second or faster.

D. Frequency of Operation: Anti-ram gate systems shall be capable of operating a minimum of 60 complete open/close cycles per hour.

E. [Corrosion Resistance: When the project site is identified by OBO as being in a moderate or extreme atmospheric corrosion risk location, the components necessary for continued operation of gate systems shall be fabricated to resist corrosion.]

F. Durability: Provide anti-ram gate systems capable of operating for 200,000 continuous cycles without failure of any component necessary for continued operation of gate. Cycle testing shall be performed in configuration where anti-ram gate itself is located in outdoor location that will expose unit to full sunlight and effects of climatic conditions at test facility (pollution, rain, snow, sleet, etc.). Anti-ram gate systems shall be capable of operating minimum of 60 complete open/close cycles per hour.

G. Control Circuits: Design control system in such a way that when power fails gate maintains "status quo" position. System shall fail neither secure nor safe. On hydraulic gate systems provide fail-safe lock system on hydraulic cylinder which prevents gate from being pushed open in event of hydraulic failure.

H. Back-up and Manual Operation: Control system shall provide back-up and manual operating capability for use in event of power failure. Manual operation of gate shall be simple and without need of special tools or knowledge. Gate shall be capable of being returned to secure position, in manual mode, in no more than 5 minutes.

I. Individual anti-ram gate systems cannot serve as sole vehicle barrier for compound and shall be mated with another Department of State approved vehicle barrier system which, in conjunction, is capable of providing EFO protection of 1.5 seconds or less.

2.2 MATERIALS, GENERAL

A. Steel Shapes, Plates, and Bars: ASTM A 36; except where otherwise indicated, and as follows:

1. Where indicated as "high-strength" steel, provide shapes, plates, and/or bars complying with ASTM A 588, Grade C, 34.9 kg/sq. mm (50 ksi) yield strength.
2. Where indicated as tubular "high-strength" steel, provide shapes, sizes, and wall thicknesses as indicated complying with ASTM A 618, Grade Ib; 34.9 kg/sq. mm (50 ksi) yield strength.

B. Steel Finishes: Hot-dip galvanize all steel components to comply with applicable standards of ASTM A 123/A 123 M for galvanizing steel products and ASTM A 153 A, 153 M for galvanizing steel hardware.

C. Welding Rods and Bare Electrodes: Provide type recommended by AWS specifications, for the metal and alloy being welded in each element of the fabrications.

D. Bolts and Fasteners: ASTM A 320, AISI Type 300-series stainless steel bolts and nuts. Where within reach of intruders working from attack-side of facilities, including working from inside sally ports, provide non-removable bolt/nut units (not removable by use of commonly available hand tools). Provide stainless steel washers.

E. Concrete Inserts: Furnish anchorage units to be placed in concrete substrates, of hot-dip galvanized cast-iron/malleable-iron body, design/type as indicated; ASTM A 153 zinc coating, ASTM A 47 casting.

F. Setting/Anchoring Cement: Provide non-shrinking, non-staining, hydraulic-controlled expansion-type cementitious compound; factory prepackaged for mixing with water at project for a pourable and trowellable mix, recommended by manufacturer for exterior exposure (ASTM C 109).

G. Aluminum Extrusions: ASTM B 221, Alloy 6005, Temper T5 or T6; sizes, shapes, and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

H. Stainless Steel Tubing: ASTM A 269, AISI Type 304; sizes and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

I. Coatings for Fabricated Steel: Provide galvanized coating including chemical cleaning complying with SSPC-SP1, followed by pickling treatment complying with SSPC-SP8, followed by hot-dip zinc coating complying with ASTM A 123. Provide prime coat recommended by finish coat manufacturer consisting of hot-phosphate solution treatment, followed by chrome-acid rinse, and followed by dip-metal primer coating which is oven dried for 30 minutes at 150 deg C (300 deg F). Provide special finish coating of polyester or acrylic enamel, electrostatically applied and baked on in accordance with coating manufacturer's instructions to dry film thickness of 1.5 mils (0.038 mm); color as indicated or, if not otherwise indicated, as selected by Project Director/COR from submission of available colors. Finish steel fasteners and accessories with same or equivalent finish.

1. Provide touch-up paint with each painted gate.

J. Gate panels and gate operators shall conform to UL325. Gate operators shall be listed by a testing laboratory.

K. Use high speed gate operators on UL 325, Class III and Class IV installations only.

2.3 GATE FABRICATION

A. General: Fabricate anti-ram gates at the factory to the greatest extent possible, including interfacing, supporting, and anchorage provisions as required for installation. Fabricate to comply with indicated performance requirements. Disassemble only to the extent required for handling, delivery, and installation. Provide anti-ram gate systems with all components designed and

assembled by the gate manufacturer. The entire gate system shall be a complete kit warrantied by the gate manufacturer.

B. Fabricate gates as follow:

1. Use only electric, hydraulic, or pneumatic drive systems for anti-ram gate systems.
2. Provide 24 VDC, battery backed-up control circuitry.
3. Provide system which retains gate in current position when there is a power failure.
4. Provide a system for back-up for the control systems, and for manual operation of gate when there is a power failure.
5. Provide lifting points for maintenance.
6. Hydraulic Lines: Where power and hydraulic lines are required and are below grade, protect lines with rigid electrical conduit. Where temperatures will exceed 38 degrees C (100 degrees F) for extended periods of time, provide a cooling unit for the hydraulic fluid as recommended by the manufacturer.
7. Provide disconnect switch in secure location.
8. Fabricate gate panels and supporting elements and appurtenances so that a 130mm diameter sphere cannot pass through any portion of the gate panel or any location where the gate panel interfaces with the surrounding construction (on the attack side), including where the gate panel meets the ground.
9. Fabricate units with member sizes, shapes, and spacings as shown, and with overall dimensions of each unit as shown. Provide vehicle gates with anti-climb protection, and which comply with UL325 and ASTM F2200.
10. Fabricate fencing component of gate to be coordinated with and to complement the style of fencing work that is part of perimeter barrier or used in other portions of the compound; see Section 323118 “Decorative Metal Fences and Gates.”
11. Ease exposed edges of fabricated metal elements to approximately 0.8mm (1/32-inch) radius, prior to finishing.
12. Avoid the use of bolts and screws exposed and accessible from the exterior (attack side) of fabricated units. Where unavoidable, provide non-removable (with ordinary hand tools) type fasteners in the assembly.
13. Provide matching padlock eyes for each (closed) gate, located on inside (secure side) of fence except where indicated as exterior.
14. Design load bearing gate to be easily serviceable and to withstand dead/live load with minimum safety factor of 2. Minimum two, tandem (truck style) V-wheel assemblies per gate leaf, 150 mm diameter steel machined wheels with sealed roller bearings and pivoting brackets, 2200 kilogram minimum capacity.
15. Guide or support wheels shall utilize nylon or synthetic roller and sealed maintenance free bearings and be capable of up and down movement to compensate for uneven tracks, providing constant engagement with the gate leaf as it travels.
16. V-track should be poured in place, level, plumb and straight and run the continuous length of both full open and full closed gate travel.
17. **[Ice Melting: Provide in-ground ice/snow melting capability in the sallyport and sidewalks surrounding the CACs when located in a heavy snow/ice environment.]**
18. Provide lane indicator lights, red and green, to indicate the direction of traffic when more than one lane of traffic exists in the sallyport.
19. Provide physical stop at both ends of the gate assembly.
20. Provide limit switches.

21. Provide “open gate annunciator”, voice annunciator that signals that the gate has been left open after 60 seconds in the open position. For perimeter gates the annunciator shall annunciate; “the perimeter gate is open.” For compound side sallyport gates, the annunciator shall annunciate: “the compound gate is open.”

2.4 GATE OPERATOR

A. General: Design operator for continuous duty in high-cycle applications and require low maintenance. Operation shall be by means of a metal rail passing between a pair of solid metal wheels with polyurethane treads. Operator motors shall be hydraulic, and system shall not include belts, pulleys, roller chains or sprockets to transfer power from operator to gate panel or approved equal. The operator shall be capable of actuating gates up to 5 meters in overall length. The gate operator shall feature a ‘soft start’ and ‘soft stop’ to minimize shock loads to the gate and maximize hardware life.

1. The housing cover shall be able to accept a lock. All operator cover locks are to be keyed alike.
2. Remote or separate hydraulic or battery enclosures shall feature a lockable enclosure.
3. Chassis: 6mm (0.25 inch) steel base plate and 2.66 mm (12 gauge) sides and back welded and ground smooth.
4. The housing and chassis shall be galvanized per ASTM 123M for corrosion resistance in all environments.
5. Electrical enclosure: Oversized, metal, with hinged lid gasketed for protection from intrusion of foreign objects and providing ample space for the addition of accessories.
6. Hydraulic fluid: High performance type with viscosity index greater than 375 and temperature range -40 C to 75 C degrees (-40 F to 175 F).
7. All components shall have overload protection.
8. Control circuit: 24VDC.
9. Built-in “warn before operate” system.
10. User relay outputs options, “gate open 60 sec” alert and “gate operator tamper switch” for connection to user control panels.
11. Display for system configuration and reporting of control status.
12. Heating and Cooling System: Provide heating and cooling system per manufacturers' recommendations.
13. Hydraulic systems featuring an accumulator to accomplish the required two complete cycles after primary power failure shall also include a hand pump to manually recharge the accumulator once depleted.
14. Hydraulic systems featuring an accumulator to accomplish the required two complete cycles after primary power failure shall feature a battery or UPS system to maintain electrical control function for automatic operation of the gate after primary power loss. Requiring manual actuation of hydraulic valves shall not be acceptable during accumulator or battery driven operations.
15. Fully battery-operated gate operators are considered equal to accumulator supported systems, but must meet same post power failure, cycle and control performance criteria.
16. Manual Operation: Provide gate operating system with capability of disengaging the drive mechanism without the use of tools, so that the gate can be manually operated. The release

mechanism must not be accessible from the threat side of the gate. The gate panel shall be securely locked in place any time the drive assembly is engaged.

17. Gate operation systems which feature any significant components housed below grade shall include a sump pump.

2.5 CONTROL SYSTEMS

A. Provide touch screen control systems capable of the operations identified in this Article.

B. Gate Control: Provide fabricated perimeter gates that are capable of being controlled remotely from the Secondary control panel within the CAC guard booth with override capabilities from the Primary control panel in MSG post 1. The emergency switch or switches for the Secondary control must not be equipped with reset capability.

C. Provide a Secondary control panel at guard booth location with open/close buttons, Emergency Fast Operation (EFO) button (two stage button) and an audible annunciator, which is automatically activated when gate remains in open position in excess of adjustable time period, with adjustment capability up to 60 seconds. Provide either rack mounted or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate selection with the architectural and technical security systems design.

D. Provide Primary control panel at Post 1 location with open/close buttons, Emergency Fast Operation (EFO) button and signal light, activated by operation of annunciator signal at CAC location. Provide reset, which can also be used to deactivate signal at CAC. Provide rack mounted controls only; see Section 280508 “Common Work Results for Technical Security Systems” for racks. On dual or multiple lane sally ports or installations with more than two gates provide a custom panel that consolidates controls (separate controls and EFOs required for each gate; however, open gate annunciator may be combined per sally port).

E. Provide Emergency Fast Operation (EFO) control system that overrides all safety and obstruction components of gates when in emergency modes. Provide EFO speed of 8 seconds.

F. Provide an “emergency stop” button at both control panels.

G. Primary power failure must not result in any uncommanded motion, activation, or disruption of the gate or controls.

H. Provide an infrared vertical safety light curtain that provides continuous coverage not less than 1067 mm (42 inches) high at each side of the gate (attack and secure). Mount 125 mm (5 inches) above finish grade. Flush or surface mount so that equipment does not project more than 45 mm (1.75 inches). Controls must be configured to stop gate when plane of light curtain is broken, except when EFO system is engaged.

I. Traffic lane indicator light controls (if applicable, multi lane sallyport only).

J. Controls must result in an installation which complies with the operational testing requirements identified in Article on FIELD TESTING.

K. Provide touch screen control systems capable of the following:

1. Provide systems that have programming systems that are editable by end user. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).
2. Provide units capable of being mounted in 480 mm (19”) racks or on a desktop.
3. Open/close control buttons.
4. Emergency Operate Button (EFO): EFO button shall be separate physical two stage button. Each barrier must have its own EFO button.
5. Status Lights: Provide gate status indicators that indicate:

    a. Visual indication light when the gate is in open position.
    b. Visual indication light when the gate is in closed position.
    c. Audio and visual indication signal when gate is in open position for more than 60 seconds.

6. Primary controller: Provide Primary control system in Post 1 or Security Control Center (SCC). Primary control panel shall be capable of overriding Secondary panels. Panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections); custom made control panel units are not permitted. Primary control panel shall not require keys for operation.
7. Secondary controller: Provide Secondary control system in vehicle control booths of CAC’s or other facilities. Secondary control systems shall be capable of being overridden by Post 1 or the SCC. Panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections); custom made control panel units are not permitted. Secondary control panel shall not require keys for operation.
8. Interlocking functions: Provide control systems capable of locking out the sallyport gate open operation when vehicle gate located on perimeter side of sallyport is in open position. Provide two stage button override control of interlocking feature at Post 1 or SCC.
9. Self-diagnostic systems: Provide gate control systems capable of self-diagnosis. Minimum features required are:

    a. Audit Trail: Provide audit trail of open, close, EFO, interlock and reset functions of gate that is easily user interpreted.
    b. Cycle counter: Provide cycle counter that records each cycle of gate. Provide gate cycle counter in gate and in control system. Cycle counter in gate unit shall be readily visible to maintenance staff monitoring gate.
    c. Lifecycle Function: Lifecycle function that alerts the maintenance staff of required or upcoming necessary maintenance.
    d. Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 “Security Management System Enterprise (SMSe). Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System must require a user ID and Password for access to secure connection.
    e. Troubleshooting: Provide systems that have troubleshooting function. Troubleshooting function shall contain standardized code system or language that is

consistent for each of manufacturer's gate systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.

f. Pressure monitoring meter: Provide pressure monitoring meter on hydraulic and pneumatic units. Provide low pressure alarm to warn when pressure has dropped below 4.14 MPa (600 PSI)) in unit.

g. Low oil level monitor: Provide monitor that warns gate operator when oil level in unit is low.

10. Monitor screens: Provide monitors with minimum 175 mm (7 inch) screen size. Monitor screens shall provide clear readable views of controls in bright sunlight and glare conditions. Monitors shall be Thin Film Transistor (TFT) Liquid Chrystal Display (LCD) type, high contrast color screens, 1280 x1024 pixels. Centered under control, provide label of which gate is being controlled (e.g., "Main Perimeter Side Gate "). Text of label shall be clear and easily readable with minimum font size of 24 point, Times New Roman Bold. Directly to left of label, locate gate "OPEN" button. Open button shall be minimum of 20 mm in diameter and labeled below button "OPEN" with clear and easily readable, minimum 32 point font, Times New Roman Bold. Directly to right of label locate gate closed "CLOSE" button. CLOSE button shall be minimum of 20 mm in diameter and labeled below button "CLOSE" with clear and easily readable, minimum 24 point font, Times New Roman Bold.
11. Standardized controllers: Provide controllers capable of operating up to two gates and two barriers per controller unit.
12. Equipment and components: Provide only programmable logic controllers (PLCs) and other components that are compatible with RS232 and CAT 5 technologies.
13. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting unit or inadvertently triggering system.
14. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.6 ACCESSORIES

A. Gate operator tamper switch.

B. Remote control panel with annunciator, override and reset.

C. Emergency Manual Operation: A hand pump shall be furnished to allow gate to be opened manually in event of prolonged power interruption.

D. Emergency fast operation.

E. Low fluid level switch.

F. Export packaging.

G. Electrical disconnect at the hydraulic unit.

H. Uninterrupted Power Supply (UPS) for Primary and Secondary control panels.

I. Lock for operator cover.

J. Safety light curtain.

K. [Provide Power unit enclosure where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS. Steel enclosure shall be minimum of 2 mm thick steel and provided with DS approved padlock. Enclosure may be custom fabricated if not a standard accessory from power unit manufacturer.]

L. [Heating unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]

M. [Cooling unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]

PART 3 - EXECUTION

3.1 EXAMINATION, COORDINATION, PREPARATION

A. General: Examine substrate work, being prepared as work of other sections, for the anchorage and support of perimeter gate facilities of this section. Deliver anchorage inserts, sleeves, and other elements to be cast in concrete work, prior to time scheduled for placement of concrete. Furnish instructions, setting diagrams, templates, and/or other information for elements to be installed as work of other sections. Set posts, frames and similar elements plumb, level and true to line and location; and support adequately during placement of concrete.

B. Examine prefabricated units, and preparations made and to be made as work of other Sections, and confirm that interfaces and support of work of this section will achieve performances and align within installation tolerances.

C. Coordinate installation of gate facilities with installation of related work, to ensure optimum sequencing of interfaces.

3.2 INSTALLATION

A. Comply with fabricator's instructions for the handling, protection, assembly, installation, anchorage, and other required interface connections of gate with other work. Set level and plumb, true to line and location. Anchor to develop full-strength resistances against attacks and forced-entry attempts.

1. Install exposed gate hardware, track, and devices with non-removable fasteners, where exposed to attack side. Assemble gate operating equipment and control system for smooth, secure gate movements, with ground-set items anchored in concrete supports. Comply with applicable installation provisions of ASTM F 1184, UL325, and ASTM F2200.

3.3 TESTING AND ADJUSTING

A. Test gate operator through ten full cycles and adjust for operation without binding, scraping, or uneven motion. Test limit switches for proper 'at rest' gate position.

B. Test operate each gate facility operational unit through repeated cycles of operation; and demonstrate operation, controls, safety devices, signals, and other features to Project Director/COR. Provide adjustments as requested to comply with requirements and intended cycles of use and operation.

C. Instructions for testing anti-ram gate systems from Secondary Control Panel:

1. Open and Close and listen for binding or rubbing.
2. Check light curtain for function, reverse, or stop of gate while going closed.
3. Check open gate annunciator. Leave the gate in the open position. After a preset period (no more than one minute) an alarm will sound from the Secondary unit and from the Primary Control Panel. This timer can be set in gate operator panel.
4. Test the emergency close function. Be sure there is no vehicle or individual standing near the gate and have a safety person control the site. Check to make sure all safety functions are disabled while the gate is operating in the emergency mode.

   a. Activate the emergency close, from the open position - the gate should close quickly. Record the time (should be 8 seconds). The Secondary controller should now be inoperative and will have to be reset from the Primary controller in MSG Post I.

5. Test that the gate locks when the power is cut and the back-up system is depleted.
6. Test that the gates and controls will work under generator power from Secondary control station.
7. Test that with power cut to both hydraulic pump and controls that gate functions two full cycles with all AC power shut off.
8. Cut all power to the hydraulic pump or electrical supply and test that the gate can be operated manually.

D. Instructions for testing anti-ram gate systems from Primary Control Panel

1. Test function of traffic lane indicator lights if applicable.
2. Cycle gates Open and Closed while listening for binding or rubbing.
3. Check light curtain for function, reverse, or stop of gate while going close.
4. Check open gate annunciator. Leave gate in open position. After preset period (no more than one minute), an alarm shall sound from Secondary unit and from Primary control panels. This timer can be set in gate operator panel.
5. Test emergency close function; ensure that no vehicles or individuals are standing near gate, and have safety person control site. Ensure that all safety functions are disabled while gate is operating in emergency mode. Activate emergency close from open position; gate should close quickly. Record time; an acceptable closing time is 12 seconds or less. Secondary controller should now be inoperative and will have to be reset from Primary controller in MSG Post 1. Confirm that Secondary panel is completely disabled. Then

confirm that 'reset' button in Primary Control Panel reactivates Secondary Control Panel buttons and switches.

6. Test that gate locks when power is cut and back-up system is depleted.
7. Test that gates and controls work under generator power from Primary Control station.
8. Test that, with power cut to both hydraulic pump (where applicable) and controls, gate still functions two full cycles with all AC power shut off.

3.4 CLEANING AND FINISHING

A. Clean exposed surfaces of gate facilities, including primed surfaces and finished surfaces, exercising care to avoid damage to finishes; touch up minor blemishes in finished surfaces.

B. Refer to Division 09 Section on high-performance coatings for application of field-applied finish coatings over shop-applied primer coatings; not work of this section.

3.5 MANUFACTURER'S SERVICE

A. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 TRAINING

A. Operator Training: Manufacturers' representative shall provide initial Operator training to Local Guard Force (LGF) personnel. Training shall be delivered at post of installation within one business day following commissioning of new system. Initial Operator training shall include:

1. Overview of system.
2. Essential controls and displays.
3. Safety precautions.

B. Supervisor Training: Manufacturer's representative shall provide initial Supervisor training for Regional Security Officer (RSO) or designated representative, LGF supervisor, and others as identified by the RSO. This training shall be delivered at post of installation within one business day following commissioning of new system. Initial Supervisor training shall include:

1. Overview of system.
2. Understanding of system's purpose and capabilities.
3. Essential controls and displays.
4. Safety precautions.

C. Maintenance Training: Manufacturer or representative shall provide Maintenance training, including MANUFACTURER'S CERTIFICATION TRAINING to level of "Factory Authorized Technician" status at manufacturer's facility for the following personnel:

1. Two instructional personnel from DS/SECD/TTB.

2. One instructional designer from Instructional Systems Management Branch (DS/TPS/ISM).
3. One DS/C/ST subject matter expert (SME).
4. One person from OBO/CFSM/SM/SCD/TSB.

D. Manufacturer shall provide no less than two additional spaces per each Maintenance training class and/or training at their manufacturing facility for other DOS-designated personnel. This training shall encompass all aspects of operations, maintenance, safety and repair.

E. Maintenance training shall enable personnel listed in this section to perform routine maintenance and inspection requirements, in compliance with manufacturers' requirements.

F. Manufacturer shall make available annual refresher or re-certification Maintenance training for personnel identified in paragraph on "Maintenance Training" above.

G. System upgrades that require more than four hours for operator accommodation shall require operator and supervisor training as specified in of this specification as for new system.

END OF SECTION 324004

SECTION 324007 - ACTIVE ROADWAY BARRIER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this section includes, but is not necessarily limited to, the following elements as indicated on Drawings located in compound perimeter at entrance/exit gate locations to control passage of vehicles through compound perimeter:

1. Active anti-ram roadway barriers, for vehicle arrest at sally port configurations in perimeter protection system.

2. Controls:

a. Primary:

1) Interface: **[Physical button][Touchscreen]**.
2) Location Type: **[Rack mounted][Countertop unit]**.

b. Secondary:

1) Interface: **[Physical button][Touchscreen]**.
2) Location Type: **[Rack mounted][Countertop unit]**.

B. Related Sections include the following:

1. Section 033000 "Cast-In-Place Concrete" for requirements of concrete foundations, barriers, fences, slabs, and other elements of work in and around entrance/exit of the perimeter.
2. Section 055005 on “Metal Fabrications.”
3. Division 09 sections for field applied finish work at entrance/exit locations.
4. Division 26 and 27 sections for electrical/electronic work; including lighting, interlocks, communication systems.
5. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
6. Section 285115 “Security Management System Enterprise (SMSe).”

1.2 SUBMITTALS

A. General:

1. Submittals should be accepted by the Project Director/COR prior to procurement of associated items by Contractor; premature procurement is at the risk of Contractor.
2. Use same names for barriers in submittals as used for labels on control system; see Part 2 Article on IDENTIFICATION.
3. Refer to Division 01 Section on Submittals for general administrative requirements.

B. Product Data:

1. Product data for each element of work, whether purchased from other manufacturers or provided as barrier fabricator's standard production. Include data substantiating that products comply with requirements of these specifications.
2. Product data for each primary material used in fabricating custom produced elements of the work; along with manufacturer's descriptive literature for standard or customized products, fabrications, assemblies, devices, and accessory items used to produce work of this Section. Include mechanical, electrical, and control data for operative and motorized units, along with spare parts listing and maintenance manuals. Include performance charts and curves. Include complete list of equipment and materials. Identify applicable industry standards and how they apply to specific components. Provide a copy of the ladder logic or other programming data specific to project installation as part of the as-builts.

C. Shop drawings for each type and size of customized fabrication or assembly, showing installation requirements for each element of the work of this section. Show plans, elevations, and sections at not less than 1:20 scale, and details at 1:5 scale. Shop drawings shall contain complete wiring and schematic diagrams; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and include the layout of barrier as they related to the sally port, compound access control building, gates to include the foundations interface of the barrier and any overlapping anti-ram fixed elements, and anchorage of equipment and appurtenances, and equipment relationships to the other parts of the work including foundation and clearances for maintenance and operation. Shop drawings must also indicate all applicable accessories and features that are to be provided.

1. Controls: Provide project specific information on controls including type of controls, layout, buttons, panels, monitor screens, indicator lights and labeling. When applicable, show layouts for Primary and Secondary controls. When applicable, for screen controls on monitor screen show graphic representation of controls and layout of each screen. For all controls, provide sequence of operations to include functionality with safety devices and lock-out functionality.

1.3 INFORMATIONAL SUBMITTALS

A. General:

1. Submit Informational submittals at least four weeks prior to installation.
2. Refer to Division 01 Section on submittals for general administrative requirements.

B. Installer Qualification Data: Submit resumes of all installers documenting the installers have installed similar barrier system within the last 5 years. The resume must include at least 3 references (including contract information) that can provide verification that the installer has the expertise required to perform a successful installation and shall include training by the manufacturer for the team leader, as a minimum. The installer's qualifications must be approved by the Project Director/COR with input from an OBO/CFSM/SM physical security engineer.

C. Previous Successful Use: Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.

D. Manufacturer's Certification: Documentation that system is tested and certified by ASTM in accordance with Article on QUALITY ASSURANCE. Certified performance compliance documentation, to the extent elements are indicated with specific performance requirements; including actual crash test reports, equivalency certifications, design/analysis calculations, and similar data suitable for the demonstration of performance achievement.

1. See also Article 2.1 CORROSION RESISTANCE PERFORMANCE.

a. For stainless steel barriers either provide a barrier that has been tested with the components made of stainless steel or provide a technical evaluation for a mild steel barrier that has been redesigned as a stainless-steel barrier for OBO/PDCS/DE/CSE and DS/PSD/RD review and approval.

1) Manufacturer submittal must include an evaluation of all critical elements, to include structural elements and welds by and licensed PE comparing the "as-tested" design with the stainless-steel design with regards to design crash load. Calculations/Evaluation shall be performed by an independent engineer and stamped.
2) Provide Quality Control Plan demonstrating that the manufacturer has the capability to fabricate stainless-steel and welders that are certified for the type of stainless steel to be used and the anticipated weld lengths per AWS.
3) Once stainless has been reviewed and approved, information noted above in the Article STAINLESS STEEL BARRIER technical evaluation will not be required to be submitted for individual jobs.

E. Anti-ram Test Report: Provide a copy of the complete testing report in booklet form showing all crash tests, rating, results to demonstrate compliance with specified performance criteria.

F. Durability Submittals: Submit one of the following based on Contractor's selection, and in accordance with Durability requirements in Article on PERFORMANCE REQUIREMENTS.

1. [Test Reports: Provide independent laboratory test reports using ISO/IEC 17025 (second edition) confirming the barrier system meets the performance requirement for operating under specified number of cycles.]
2. [Durability Warranty: Provide warranty for durability of operation.]

G. [Corrosion Resistance Warranty: Submit Special Project Warranty as specified. See ARTICLE SPECIAL WARRANTY.]

1.4 CLOSEOUT SUBMITTALS

A. Test Reports: Upon completion and testing of the installed system, a test report shall be submitted in booklet form showing all fields tests, including component adjustments and demonstration of compliance with the specified performance criteria. Each test report shall indicate the final position/location of the primary and secondary controls.

B. All closeout manuals, such as operation and maintenance manuals are required in both printed and printable electronic formats. Along with copies required as part of Division 01 "Construction Submittals, deliver two copies of these manuals, incorporating all revisions, with system at time of commissioning. These copies shall be sent via commercial courier service with one going to the Bureau of Diplomatic Security, address below, and the other to the Department of Sate Commissioning agent, cognizant post or as direct by the US Government contracting officer representative:

U.S. Department of State
Bureau of Diplomatic Security
Attn: DS/FSE/FSB – Vehicle Barrier Program Manager
SA-24 Kingstown
5800 Barclay Drive
Springfield, Virginia 22315

1. Submit copyright release for all documentation to permit reproduction and use of this material on Department of State internal automated information system networks.

C. Operation and Maintenance Manuals: Submit Operation and Maintenance data in accordance with Division 01.

1. Operation instructions shall outline the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacture's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.
2. Maintenance instructions shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include piping layout, equipment layout and simplified wiring, and control diagrams of the systems as installed.
3. Provide backup copies of all software needed to restore a system.
4. Grant internal distribution rights of all necessary manuals and technical documentation.

D. Spare Parts Data: After approval of the shop drawings the Contractor shall submit spare parts data for each different item of materials and equipment used. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

E. [Maintenance Plan for Corrosive Environments: The manufacturer shall develop and submit a site-specific routine maintenance plan tailored to local conditions and executable by the local labor force. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.

1. Plan shall be based on a 25-year life span and show schedule for full life span.
2. Include routine cleaning schedule and inspection for corrosion, to include arresting chains.
3. Provide instruction for how to repair minor rust of elements and how to determine if an arresting chain needs to be replaced.
4. Provide instruction for inspecting for painted coating and instruction for repair and repaint.]

F. Training Documentation: Immediately upon completion of Operator and Supervisor training, documentation of training shall be delivered to Project Director/COR of installation. Training documentation shall include:

1. The date and time of the training.
2. A list of the names of the personnel trained.

1.5 QUALITY ASSURANCE

A. Nameplates: The vehicle barrier shall have the manufacturer's name, contact for service, and catalog or serial number permanently affixed to a plate securely attached to the equipment in a suitable location.

B. Verification of Dimensions: The Contractor shall become familiar with all details of the work and verify dimensions in the field as required for coordination.

C. Performance Evaluation: The barrier system shall comply with ASTM F 2656, Standard Test Method for Vehicle Crash Testing of Perimeter Barriers, latest revision. Conform to vehicle resistance standards identified in Article on PERFORMANCE REQUIREMENTS.

D. Installer Qualifications: Engage an experienced Installer who has completed in last five years an active roadway barrier system installation similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver elements of the active roadway barrier systems to the project with assemblies prefabricated, prefinished, and equipped with devices and accessories to the greatest extent possible. Comply with Government's criteria for packaging, handling, protection, storage, and delivery.

1.7 [WARRANTY

A. Special Project Warranty:

1. Durability: In lieu of the of the cycles testing, the manufacturer may provide a 5-year comprehensive onsite material and labor warranty for any component necessary for continued operation of the barrier system.
2. Corrosion Resistance: All elements of the active roadway barrier system shall be designed and constructed to resist these effects for a period of 10 years from Substantial Completion. Should corrosive damage inhibit or halt the operation of the barrier system replacement parts or new barrier systems shall be shipped to the project site (at no cost to the USG) and installed by qualified installers provided by the manufacturer. The government at its sole discretion may opt to install the manufacturer provided replacement parts, however this will in no way void or alter the warranty.]

1.8 EXTRA MATERIALS

A. Spare parts kit per manufacturer's recommended list for 1 to 2 barriers to include:

1. Hydraulic Barrier System

a. Power Supply
b. Motor
c. Motor Starter
d. Pressure Switch
e. Starter Overload
f. Control Card/Circuit Board
g. Control Panel
h. Vehicle Loop Detector/Sensor
i. HPU Oil Heater
j. Sump Pump
k. Touch screen
l. Control Panel
m. Any parts required for scheduled maintenance for the first 200,000 cycles.

2. Electro-Mechanical Barrier System

a. Power Supply
b. Actuator
c. Surge Protector
d. Fuses
e. Input Module
f. Output Module
g. IR Sensor Pair (Transmitter and Receiver)
h. Loop Detector Sensor
i. Springs (Minimum 2)
j. Sump Pump
k. Touch screen
l. Control panel
m. Any parts required for scheduled maintenance for the first 200,000 cycles.

B. Spare parts kit per manufacturer's recommended list for 3 or more barriers:

1. Three to four barriers: multiply quantities in Part A by 2
2. Five to six barriers: multiply quantities in Part A by 3
3. **[Six or more barriers: Coordinate/specify quantities with the assistance of OBO/CFSM/SM]**

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide active roadway barrier systems in accordance with ASTM F2656 and the OBO Zoning Code.

B. Vehicle Resistance: Provide active roadway barrier systems which are produced by manufacturers who have previously produced, within the last two years, units of similar security attack resistance of equivalent size and resistance ratings, and which have been certified by the Bureau of Diplomatic Security (DS). Required performance is for a test rating of **[M50] [M40] [M30]** per project location design via speed approach calculations with maximum vehicle penetration of P1. Provide barrier capable, in width of operation, of obstructing vehicular traffic in a 4 meter (13 ft) wide traffic lane.

C. Corrosion Resistance Performance

1. Corrosion Risk: As indicated in the Project Contract (e.g., Statement of Work the OBO Building Code Appendix W defined OBO Atmospheric Corrosivity Level for this site is **[Low][Moderate][Extreme]**. The atmospheric corrosion risk exposure risk type for a given component shall be as defined by OBO Building Code R101.1.2 (i.e., direct exterior, indirect exposure to exterior, and interior exposure only).
2. Corrosion Resistance Standards: Provide materials and finishes for the components in accordance with the material specifications of this Specification Section and the general material type as indicated by this article for the project-specific corrosion risk identified above or elsewhere in the Contract Documents.
3. Material Standards for Barrier Components (e.g., inserts, tie rods, hardware, clips and fasteners, steel plates and shapes). As applicable for the OBO Atmospheric Corrosivity Level (ACL) of site and for both direct exterior exposure and indirect exposure to the exterior:

   a. Mild Steel: hot-dipped galvanized coating; low and moderate ACL.
   b. Stainless Steel: low, moderate, and extreme ACL.

4. Exterior Environmental Protection Covers: as applicable for the OBO Atmospheric Corrosivity Level (ACL) of site and for both direct exterior exposure and indirect exposure to the exterior:

   a. Stainless Steel: AISI Type 316/316L, 2101 or 2205; low risk, moderate risk, and extreme ACL.

5. Arresting Chains: hot-dipped galvanized coating; low, moderate, and extreme ACL.
6. For reinforcing steel and concrete: See Article DIVISION 3 CONCRETE.
7. Finish Standards for Components: as applicable for project site.

D. Durability: Provide active roadway barrier systems capable of operating for 200,000 continuous cycles without failure of any component necessary for continued operation of barrier. Cycle testing shall be performed in configuration where active barrier itself is located in outdoor location

that will expose unit to full sunlight and effects of climatic conditions at test facility (pollution, rain, snow, sleet, etc.). Active roadway barrier systems shall be capable of operating a minimum of 60 complete up/down cycles per hour.

E. Provide power-operated barrier activation equipment, which is capable of fully activating the barrier in 4 seconds under normal operating conditions, and which is capable of fully activating the barrier in 1.5 seconds under emergency conditions (EFO). Operation of the emergency activation of the barrier requires a reset of the control system in order to retract the barrier; and that is possible only at primary control panel.

F. Provide system components that accept a full range universal AC power (100 VAC – 240 VAC ± 10 percent, 50 Hz – 60 Hz ± 10 percent).

G. Status Indicators: Vehicle arrest system shall provide a clearly visible device, such as signal light or drop arm, to indicate barrier's status to approaching driver.

H. Provide barrier vehicle detector safety loop to prevent barrier from being accidentally raised under authorized vehicle. This should detect vehicle at any point vehicle is over the barrier.

I. Control Circuits: Design control system in such a way that when power fails barriers maintain "status quo" position. System shall fail neither secure nor safe. On hydraulic barrier systems, provide fail-safe lock system on hydraulic cylinder which prevents barrier from lowering in event of hydraulic failure.

J. Back-up and Manual Operation: Control system shall provide back-up and manual operating capability for use in event of power failure. Back-up operating system shall provide, as a minimum, three complete cycles (up and down) without use of manual system. Manual operation of barrier shall be simple and without need of special tools or knowledge. Barrier shall be capable of being returned to secure position, in manual mode, in no more than 5 minutes. Battery backup systems shall be 24 to 100 volt or less, systems.

K. Reliability: The barrier system must provide maximum dependability and ease of maintenance. The system must be designed to function consistently in all DOS locations throughout the world.

L. Hydraulic Lines: Where power and hydraulic lines are required and are below grade they must be protected with rigid electrical conduit. Where temperatures will exceed 38 degrees C (100 degrees F) for extended periods of time provide a cooling unit for the hydraulic fluid.

M. Installation: The barrier system shall require no more than 600mm (24 inches) to accommodate its foundation.

N. Serviceability: Panels and sealing features mounted on the barrier shall be removable to facilitate maintenance and repair without the use of specialized tools

O. Hydraulic System: The hydraulic system (if so equipped) shall consist of an electrically driven hydraulic pump which shall pressurize a high pressure manifold connected to a hydraulic accumulator. The hydraulic system shall include all necessary control and logic devices, lines and valves to override and lock out the normal speed control for emergence fast operation of the barrier.

P. The Secondary and Primary controls must have an emergency (fast operation) secure switches for each barrier. The emergency switch or switches for the Secondary control must not be equipped with reset capability.

Q. Environmental Protection of Power Units: Environmental conditions for power units shall not exceed 30 degrees C (86 degrees F) or drop below -5 degrees C (24 degrees F). If units are placed in a building space, the conditions may be achieved either by using HVAC equipment for the space, or by using an enclosure accessory for power unit with heating and cooling unit accessories as needed to maintain the environmental conditions within the enclosed container. If power unit is place outdoors, provide an enclosure as an accessory where necessary to maintain required environmental conditions, and provide heating and cooling units as accessories as needed to maintain the conditions. In addition, in locations subject to exposure to severe weather or to intensive exposure to dirt, sand, and other harmful elements, provide protection through placement in a protected building space with designed features to limit harmful elements, or by placing power unit in an enclosure. Enclosure must be constructed of minimum 3 mm (0.125 inch) thick plate steel, must be capable of being padlocked with a DS approved padlock.

2.2 APPROVED PRODUCTS

A. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Robotic Security Systems Incorporated (RSSI) RSS-2000 electromechanical vehicle barrier.
2. Delta Scientific Corporation HD300 Phalanx electromechanical vehicle barrier.
3. Delta Scientific Corporation DSC2000 hydraulic vehicle barrier.
4. Delta Scientific Corporation DSC501 hydraulic vehicle barrier.
5. Delta Scientific Corporation DSC207s hydraulic vehicle barrier; this barrier does not comply with the maximum foundation depth requirements of this Section, and therefore its use is subject to written permission from OBO.
6. Ross Security Systems LLC XT-2000 hydraulic vehicle barrier (also known as Heald Viper HD-1).
7. Ross Security Systems LLC XT-1000W5 hydraulic vehicle barrier.

B. Other Active Roadway Barrier Systems approved by the Bureau of Diplomatic Security may be used subject to the requirements of this specification and additional warranty requirements stated in this specification.

2.3 MATERIALS, GENERAL

A. Steel Shapes, Plates, and Bars: ASTM A 36 or ASTM A572; except where otherwise indicated, and as follows:

1. Where indicated as "high-strength" steel, provide shapes, plates, and/or bars complying with ASTM A 588, Grade C, 34.9 kg/sq. mm (50 ksi) yield strength.

2. Where indicated as tubular "high-strength" steel, provide shapes, sizes, and wall thicknesses as indicated complying with ASTM A 618, Grade Ib; 34.9 kg/sq. mm (50 ksi) yield strength.

B. Steel Finishes: Hot-dip galvanize all steel components to comply with applicable standards of ASTM A 123/A 123 M for galvanizing steel products and ASTM A 153/A 153 M for galvanizing steel hardware. This is applicable for all active barriers.

C. Welding Rods and Bare Electrodes: Provide type recommended by AWS specifications, for the metal and alloy being welded in each element of the fabrications.

D. Bolts and Fasteners: ASTM A 320, AISI Type 300-series stainless steel bolts and nuts **[or other corrosive resistant bolts and fasteners where galvanic action is a concern and submit selection for OBO/PDCS/DE/CSE approval]**. Where within reach of intruders working from attack-side of facilities, including working from inside sally ports, provide non-removable bolt/nut units (not removable by use of commonly available hand tools). Provide stainless steel washers.

E. Concrete Inserts: Furnish anchorage units to be placed in concrete substrates, of hot-dip galvanized cast-iron/malleable-iron body, design/type as indicated; ASTM A 153 zinc coating, ASTM A 47 casting.

F. Setting/Anchoring Cement: Provide non-shrinking, non-staining, hydraulic-controlled expansion-type cementitious compound; factory prepackaged for mixing with water at project for a pourable and trowelable mix, recommended by manufacturer for exterior exposure (ASTM C 109).

G. Aluminum Extrusions: ASTM B 221, Alloy 6005, Temper T5 or T6; sizes, shapes, and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

H. Stainless Steel Tubing: ASTM A 269, AISI Type 304; sizes and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

I. Shop Primer Paint: Fabricator's baked-on, lead-free, modified alkyd-base, ferrous-metal primer; which is compatible with finish system specified in Division 09 Sections on painting or high-performance coatings, and which will provide long-term resistance to corrosion from external exposure, and form a firm undercoat for field-applied topcoats after prolonged construction-period exposures. Comply with performance requirements of FS TT-P-645 and with paint manufacturer's instructions for baked-on primer coat material and application.

J. Shop Primer Paint: Organic, zinc-rich coating, with zinc-dust content not less than 80 percent by weight of non-volatile content; with vehicle base selected for compatibility with specified finish coating system. Comply with paint manufacturer's instructions for surface pretreatment materials and methods, and for primer application.

2.4 FABRICATION

A. General: Fabricate active roadway barrier systems at the factory to the greatest extent possible, including interfacing, supporting, and anchorage provisions as required for installation. Fabricate to comply with indicated performance requirements. Disassemble only to the extent required for handling, delivery, and installation.

1. Provide active roadway barrier system with all components designed and assembled by the barrier manufacturer. The entire barrier system shall be a complete kit fully warrantied by the barrier manufacturer.

B. Fabricate active roadway barriers for installation as shown, flush with road surface when retracted. Include the following:

1. Provide signal light to indicate barrier status (activated or retracted) to approaching vehicle driver.
2. Provide a secondary control panel (typically at guard booth location) with open/close buttons, Emergency Fast Operation (EFO) button (two stage button, see Article on ACCESSORIES) and an audible annunciator, which is automatically activated when barrier remains in retracted position in excess of adjustable time period, with adjustment capability up to 60 seconds. Provide either rack mounted or countertop-installed panels and coordinate selection with the architectural and technical security designs; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks.
3. Provide active roadway barrier system that disarms all safety components of active roadway barrier systems when in emergency mode.
4. Provide a primary control panel (typically at Post 1 location) with open/close buttons, Emergency Fast Operation (EFO) button and signal light, activated by operation of annunciator signal at CAC location; provide reset, which can also be used to deactivate signal at CAC. Provide rack mounted controls only; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. On dual or multiple lane sally ports or installations with more than two anti-ram barriers provide a custom panel that consolidates controls (separate controls and EFO’s required for each barrier; however, open barrier annunciator may be combined per sally port).
5. Provide “open barrier annunciator”, voice annunciator that signals that the barrier has been left down after 60 seconds in the down position. The annunciator shall annunciate; “the barrier is down.”
6. Provide barrier position indicator and power indicator pilot light at both control station locations.
7. Provide 24 V control circuitry of the required cycles per min. rating (depends upon available power source). Provide system which retains barrier in current position when there is a power failure. Provide a system for back-up, such as accumulators and UPS for the controls, and for manual operation of barrier when there is a power failure.
8. Equip control station at MSG guard booth location with audible annunciator, which is automatically activated when barrier remains in retracted position in excess of adjustable time period, with adjustment capability up to 60 seconds. Equip control station at MSG booth location with signal light, activated by operation of annunciator signal at vehicular compound entry location. Provide reset, which can also be used to deactivate signal at vehicular compound entry location.

9. Provide cooling unit for the hydraulic fluid of the barrier operating system if unit is hydraulic.
10. Provide disconnect switch.
11. Provide limit switch (up/down).
12. Provide safety cover that closes the gap between the barrier top and pit when barrier is in the up position.
13. Electric, hydraulic, or pneumatic drive systems may be used for barrier systems.
14. Provide vehicle barrier system (VBS) control system must have the capability to input normally open dry contacts for the following:

    a. Open command
    b. Close command
    c. EFO command
    d. EFO Reset command

15. Each VBS control system must receive inputs and provide outputs for the following:

    a. Up status indication
    b. Down status indication
    c. EFO Activated indication

16. All indoor components must function in a temperature range of 24 °F to 95 ˚F (-4 °C to 35 °C).
17. All outdoor components must function in a temperature range of -20 °F to 130 °F (-29 °C to 54 °C).
18. Each primary and secondary controller must provide a visual indicator/light for each system to show an over-current alarm, if applicable.
19. The primary operator station must provide a visual indication with audible warning annunciator for loss of the communications link between the control system and the barrier system. The indicator and annunciator must identify which unit and activate within two seconds of data communications loss.
20. The primary operator station must provide a visual indicator/light with audible warning annunciator alerting the user to debris/water that could potentially hamper barrier operation. Where applicable, the VBS controller system must discretely indicate to which power unit this alarm applies.
21. When temperature status is out of the normal operating range as recommended by the manufacturer, the primary operator station must provide a visual indication with audible warning annunciator. Where applicable, the VBS controller system must discretely indicate which power unit this alarm applies to.
22. Provide an alarm and indicate the alarm to the primary operator station to warn of necessary maintenance of any kind that the barrier is designed to schedule or detect.
23. Provide a record of all events/alarms (that it is capable of recording) of forensic analysis for troubleshooting purposes for the system and maintain in a memory storage accessible only to admin/maintenance personnel for at least 90 days preceding the present day. Where applicable, the VBS controller system must discretely indicate to which power unit this alarm applies.
24. Provide IP-addressable via an Ethernet connection using IPv4 or IPv6 transport protocols.

a. The VBS must use Network Time Protocol to allow the barrier system clock to synchronize with an external network-connected time source.
b. The VBS must use Simple Network Management Protocol (both SNMPv2 and SNMPv3) to monitor barrier system attributes, diagnostics, and status, and provide a Management Information Base file.
c. The VBS must provide access to audit trails, diagnostic information, and maintenance data through a touch-screen (if provided) and using a locally connected computer or network via an Ethernet port.
d. Provide a digital or computerized counter to record each up/down cycle of the active vehicle barrier.
e. Any included API/SDK must include alerts for maintenance, audit trails, diagnostics, etc.
f. The VBS must provide secure login for administrators and operators using unique usernames and passwords to configure or query for status and diagnostic information. Implementation of any fixed, non-changeable passwords is not allowed. See the following examples:
g. Level 1 – Normal operations
h. Level 2 – Secondary
i. Level 3 – Primary
j. Level 4 – Administrative
k. The VBS must provide auto login feature for operators/Level 1 users.
l. The VBS shall NOT use proprietary wire and/or wiring harnesses.

25. The following are optional requirements that may be required features in the future:

a. Provide a lifecycle function that alerts to required or upcoming maintenance.
b. Provide a RADIUS and Lightweight Directory Access Protocol to allow an external server to centrally control, authenticate, and authorize remote logins. Locally-stored usernames and passwords must be allowed in case the authenticating server is not available.
c. Provide a system log to send text-based audit, status, and diagnostic messages to an external receiving server.
d. Provide/use Telnet and Secure Shell (SSH), and the capability to disable, to provide a command line interface for administrators and operators.

26. The following are allowed but not required:

a. The VBS may use Hypertext Transfer Protocol (HTTP) and Secure Sockets Layer to authenticate and authorize administrators and operators. Vendor must provide capability to disable HTTP if using HTTPS.
b. The VBS may provide native Application Programming Interface (API) or Software Development Kit (SDK) for third party PSIM integration.

2.5 TOUCH SCREEN CONTROL SYSTEMS

A. If selected for use on the project, provide touch screen control systems capable of the operations identified in this Article.

B. Barrier Control: Provide fabricated anti-ram barriers that are capable of being controlled remotely from the secondary control panel (typically located within the CAC guard booth). Provide override capabilities from the Primary control panel (typically located within MSG post 1).

1. Provide units capable of being mounted in 480 mm (19") racks or on desktop. As required, provide rack mounted controls per Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. On dual or multiple lane sally ports or installations with more than two barriers, provide a custom panel that consolidates controls (separate controls and EFOs required for each barrier; however, open barrier annunciator may be combined per sally port).
2. Provide systems that have programming systems that can be adapted by end user with updated ladder logic programming from manufacturer. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).

C. Provide a secondary control panel with the following:

1. Emergency Operation (EFO) button for each barrier location (toggle switch with flip cover) (located above touchscreen and not part of the touchscreen)
2. Open button
3. Close button
4. Barrier status indicator on the screen. (i.e., open, close)

   a. Visual indication light when barrier is in open position.
   b. Visual indication light when barrier is in closed position.
   c. Audio and visual indication signal when barrier is in open position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barrier remains in the open position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. The emergency switch or switches for the secondary control must not be equipped with reset capability.
7. Provide either rack mounted or countertop-installed panels; see Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. Coordinate design and selection with architectural and technical security systems design.

D. Provide a Primary control panel with the following:

1. Emergency Operation (EFO) button for each barrier location (toggle switch with flip cover) (located above touchscreen and not part of the touchscreen)
2. Open button
3. Close button
4. Barrier status indicator on the screen. (i.e., open, close)

   a. Visual indication light when barrier is in open position.
   b. Visual indication light when barrier is in closed position.
   c. Audio and visual indication signal when barrier is in open position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barrier remains in the open position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. EFO reset button
7. Capable of overriding and disabling the secondary panel.
8. Provide either rack mounted or countertop-installed panels; see Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. Coordinate design and selection with architectural and technical security systems design.

E. Provide Emergency Fast Operation (EFO) control system that overrides all safety and obstruction components of barrier when in emergency modes. Provide EFO speed per performance section.

F. Primary and secondary control panels shall not require keys for operation.

G. Primary and secondary panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections).

H. Monitor screens: Provide monitors with minimum 175 millimeter minimum (7 inch) diagonal screen size. Monitor screens shall provide clear readable views of controls in bright sunlight and glare conditions. Monitors shall be Thin Film Transistor (TFT) Liquid Chrystal Display (LCD) type, high contrast color screens, 1280 x 1024 pixels. Each monitor shall depict barrier being controlled, at top of the screen, via video input so that barrier operator can view the barrier operation via screen. Directly below view of the barrier, centered under this view, provide label of which barrier is being controlled (e.g., "Main CAC Barrier"). Text of label shall be clear and easily readable with minimum 10mm, Times New Roman Bold. Directly to left of label, locate barrier "UP" button. UP button shall be minimum of 25 mm in diameter and labeled below button "UP" with clear and easily readable, minimum 15 mm, Times New Roman Bold. Directly to right of label locate barrier "DOWN" button. DOWN button shall be minimum of 25 mm in diameter and labeled below button "DOWN" with clear and easily readable, minimum 15 mm, Times New Roman Bold.

I. System processing control unit:

1. Self-diagnostic systems: Provide barrier control systems capable of self-diagnosis. Minimum features required are:

   a. Audit Trail: Provide audit trail of up, down, EFO, interlock, and reset functions of barrier that is easily user interpreted.
   b. Cycle counter: Provide cycle counter that records each cycle of barrier. Provide barrier cycle counter in barrier and in control system. Cycle counter in barrier unit shall be readily visible to maintenance staff monitoring barrier.
   c. Lifecycle Function: Lifecycle function that alerts maintenance staff of required or upcoming necessary maintenance.
   d. Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 "Security Management System Enterprise (SMSe)." Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System shall require user ID and Password for access to secure connection.

e. Troubleshooting: Provide systems that have troubleshooting function. Troubleshooting function shall contain standardized code system or language that is consistent for each of manufacturer's barrier systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.
f. Pressure monitoring meter: Provide pressure monitoring meter on hydraulic and pneumatic units. Provide low pressure alarm to warn when pressure has dropped below 4.14 MPa (600 PSI) in unit.
g. Low oil level monitor: Provide monitor that warns barrier operator when oil level in unit is low.

2. Equipment and components: Provide only programmable logic controllers (PLCs) and other components that are compatible with RS232 and CAT 5 technologies.
3. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting unit or inadvertently triggering system.
4. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.6 PUSH BUTTON CONTROL SYSTEMS

A. If selected for use on the project, provide push button control systems capable of operations identified in this Article.

B. Barrier Control: Provide fabricated anti-ram barriers that are capable of being controlled remotely from the secondary control panel (typically located within the CAC guard booth). Provide override capabilities from the Primary control panel (typically located within MSG post 1).

1. Provide units capable of being mounted in 480 mm (19 inch) racks or on desktop. As required, provide rack mounted controls per; Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. On dual or multiple lane sally ports or installations with more than two barriers provide a custom panel that consolidates controls (separate controls and EFOs required for each barrier; however, open barrier annunciator may be combined per sally port).
2. Provide systems that have programming systems that can be adapted by end user with updated ladder logic programming from manufacturer. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).

C. Provide a secondary control panel with the following:

1. Emergency Operation (EFO) button for each barrier location (toggle switch with flip cover)
2. Open button (green) minimum 22 mm diameter
3. Close button (red) minimum 22 mm diameter
4. Barrier status indicator light. (i.e., open, close)

a. Visual indication light when barrier is in open position.
b. Visual indication light when barrier is in closed position.

c. Audio and visual indication signal when barrier is in open position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barrier remains in the open position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. The emergency switch or switches for the secondary control must not be equipped with reset capability.
7. Provide either rack mounted or countertop-installed panels; see Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. Coordinate design and selection with architectural and technical security systems design.

D. Provide a Primary control panel with the following:

1. Emergency Operation (EFO) button for each barrier location (toggle switch with flip cover)
2. Open button (green) minimum 22 mm diameter
3. Close button (red) minimum 22 mm diameter
4. Barrier status indicator light. (i.e., open, close)

a. Visual indication light when barrier is in open position.
b. Visual indication light when barrier is in closed position.
c. Audio and visual indication signal when barrier is in open position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barrier remains in the open position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. EFO reset button (black) minimum 22 mm diameter.
7. Capable of overriding and disabling the secondary panel with turn switch (on/off).
8. Provide either rack mounted or countertop-installed panels; see Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. Coordinate design and selection with architectural and technical security systems design.

E. Provide Emergency Fast Operation (EFO) control system that overrides all safety and obstruction components of barrier when in emergency modes. Provide EFO speed per performance section.

F. Primary and secondary control panels shall not require keys for operation.

G. Primary and secondary panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections).

H. System processing control unit:

1. Self-diagnostic systems: Provide barrier control systems capable of self-diagnosis. Minimum features required are:

a. Audit Trail: Provide audit trail of up, down, EFO, interlock and reset functions of barrier that is easily user interpreted.
b. Cycle counter: Provide cycle counter that records each cycle of barrier. Provide barrier cycle counter in barrier and in control system. Cycle counter in barrier unit shall be readily visible to maintenance staff monitoring barrier.

c. Lifecycle Function: Lifecycle function that alerts maintenance staff of required or upcoming necessary maintenance.
d. Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 "Security Management System Enterprise (SMSe)." Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System shall require user ID and Password for access to secure connection.
e. Troubleshooting: Provide systems that have troubleshooting function. Troubleshooting function shall contain standardized code system or language that is consistent for each of manufacturer's barrier systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.
f. Pressure monitoring meter: Provide pressure monitoring meter on hydraulic and pneumatic units. Provide low pressure alarm to warn when pressure has dropped below 4.14 MPa (600 PSI) in unit.
g. Low oil level monitor: Provide monitor that warns barrier operator when oil level in unit is low.

2. Equipment and components: Provide only programmable logic controllers (PLCs) and other components that are compatible with RS232 and CAT 5 technologies.
3. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting unit or inadvertently triggering system.
4. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.7 IDENTIFICATION

A. Identify name to be used for labels on control system.

2.8 ACCESSORIES

A. Remote control panel with annunciator, override and reset.

B. Emergency Manual Operation: A hand pump shall be furnished to allow the barrier to be raised manually in the event of a prolonged power interruption.

C. Emergency fast operation.

D. Low fluid level switch.

E. Sump Pump: Self priming sump pump to drain water collected in barrier foundation. Pump shall have capacity to remove maximum expected rainfall per minute a distance of 5 meters to discharge drain. Pump operating voltage shall be 240 volts, 1 Phase, 50 Hertz.

F. Export packaging.

G. Electrical disconnect at the hydraulic unit.

H. Uninterrupted Power Supply (UPS) for the Primary and Secondary control panels.

I. Safety Interlock Detector: Provide barrier vehicle detector safety loop to prevent barrier from being accidentally raised under authorized vehicle. Detector shall utilize digital logic and have fully automatic tuning for stable and accurate long-term reliability. Output of detector shall delay any barrier rise signal (except for Emergency Fast Operation command) when vehicle is over loop.

J. [Provide Power unit enclosure where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS. The steel enclosure shall be minimum of 2 mm thick steel and provided with DS approved padlock. Enclosure may be custom fabricated if not a standard accessory from power unit manufacturer.]

K. [Heating unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]

L. **[Cooling unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]**

PART 3 - EXECUTION

3.1 EXAMINATION, COORDINATION, PREPARATION

A. General: Examine substrate work, being prepared as work of other sections, for the anchorage and support of active roadway barrier systems of this section. Deliver anchorage inserts, sleeves, and other elements to be cast in concrete work, prior to time scheduled for placement of concrete. Furnish instructions, setting diagrams, templates, and/or other information for elements to be installed as work of other sections. Set elements plumb, level and true to line and location; and support adequately during placement of concrete.

B. Examine prefabricated units, and preparations made and to be made as work of other Sections, and confirm that interfaces and support of work of this section will achieve performances and align within installation tolerances.

C. Coordinate installation of active roadway barrier systems with installation of related work to ensure optimum sequencing of interfaces.

3.2 INSTALLATION

A. Comply with fabricator's instructions for the handling, protection, assembly, installation, anchorage, and other required interface connections of active roadway barrier systems with other work. Set level and plumb, true to line and location. Anchor to develop full-strength resistances against attacks and forced-entry attempts.

B. Comply with manufacturer's instructions for the installation of roadway barrier units as shown; and for the mechanical/electrical interconnection of power and control elements. Install units flush with roadway surface, except as otherwise indicated.

3.3 TESTING AND ADJUSTING

A. Test operate each active roadway barrier system operational unit through repeated cycles of operation; and demonstrate operation, controls, safety devices, signals, and other features to Project Director. Provide adjustments as requested to comply with requirements and intended cycles of use and operation.

B. Instructions for testing active roadway barrier systems from Secondary Control Panel

1. Exercise Up and Down and listen for binding or rubbing.
2. Check stop & go lights.
3. Check open alarm. Leave the barrier in the open position. After a preset period (no more than one minute) an alarm will sound from the Secondary unit and from the Primary. This timer can be set in the electrical panel adjacent to the hydraulic pump.
4. Test safety loop or light curtain:

    a. Open the barrier and park a vehicle over the loop but not over the barrier. Attempt to close the barrier - it should not close. If safety system is tied to an adjacent gate sharing light curtains, test light curtains for operability.

5. Test the emergency close function. Be sure there is no vehicle or individual standing on or immediately next to the barrier and have a safety person control the site.

    a. PART I: Activate the emergency close, from the open position - the barrier should snap closed (1.5 sec). Record the time. The Secondary controller should now be inoperative and will have to be reset from the Primary controller in Post I.
    b. PART II: Now park a vehicle over the safety loop but BE SURE NO PART OF THE VEHICLE IS OVER THE BARRIER. Then follow Part I sequence - The emergency close function should now override the safety loop and the sequence should be the same as for Part I.

6. Cut all power to the hydraulic pump and test that the barrier can be operated the required number of cycles using the back-up system. Record the number of cycles.
7. Test that the barrier will work under generator power.
8. Cut all power to the hydraulic pump or electrical supply and test that the barrier can be operated full cycle of the unit under manual function.

C. Instructions for testing active roadway barrier systems from Primary Control Panel

1. Check functions 3 thru 7 above from the Primary.
2. Check reset function from Primary.

3.4 CLEANING AND FINISHING

A. Clean exposed surfaces of active roadway barrier system, including primed surfaces and finished surfaces, exercising care to avoid damage to finishes; touch up minor blemishes in finished surfaces.

B. Refer to Division 09 Sections on painting and on high-performance coatings for application of field-applied finish coatings over shop-applied primer coatings; not work of this section.

3.5 MANUFACTURER'S SERVICE

A. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 TRAINING

A. Operator Training: Manufacturers' representative shall provide initial Operator training to Local Guard Force (LGF) personnel. Training shall be delivered at post of installation within one business day following commissioning of new system. Initial Operator training shall include:

1. Overview of system.
2. Essential controls and displays.
3. Safety precautions.

B. Supervisor Training: Manufacturer's representative shall provide initial Supervisor training for Regional Security Officer (RSO) or designated representative, the LGF supervisor, and others as identified by RSO. This training shall be delivered at post of installation within one business day following commissioning of new system. Initial Supervisor training shall include:

1. Overview of system.
2. Understanding of system's purpose and capabilities.
3. Essential controls and displays.
4. Safety precautions.

C. Maintenance Training: Manufacturer or representative shall provide Maintenance training, including MANUFACTURER'S CERTIFICATION TRAINING to level of "Factory Authorized Technician" status at manufacturer's facility for the following personnel:

1. Two instructional personnel from DS/SECD/TTB.
2. One instructional designer from DS/TPS/ISM.
3. One DS/C/ST subject matter expert (SME).
4. One person from OBO/CFSM/SM/SCD/TSB.

D. Manufacturer shall provide no less than two additional spaces per each Maintenance training class and/or training at their manufacturing facility for other DOS-designated personnel. This training shall encompass all aspects of operations, maintenance, safety and repair.

E. Maintenance training shall enable personnel listed in this section to perform routine maintenance and inspection requirements, in compliance with the manufacturers' requirements.

F. The manufacturer shall make available annual refresher or re-certification Maintenance training for personnel identified in Paragraph on "Maintenance Training" above.

G. System upgrades that require more than four hours for operator accommodation shall require operator and supervisor training as specified in this specification as for a new system.

END OF SECTION 324007

Certificate of Compliance

Active Roadway Barrier Systems

Barrier Number_____
(Per Construction Documents)

Manufacturer Name and Model Number_____

Serial Number_____

The contractor shall complete the Certificates of Compliance in full prior to acceptance of the Anti-Ram Vehicle Barrier products by DOS. A Certificate of Compliance is required for each individual installed product. Each Certificate of Compliance shall be completed by the Installer Team Lead and the Contractor's Quality Control Manager.

		Installer Team Lead Initials / Date	Contractor QC Manager Initials/Date
1	Employees performing the installation meet the specified training and experience qualifications.		
2	Identification tags have been provided and installed with accurate product and certification information		
3	Barrier has been installed level and in accordance with the approved shop drawings.		
4	Barrier is located and installed such that the barrier leading edge, when in deployed position, is within maximum allowable horizontal gap of 1200 mm to adjacent anti-ram construction.		
5	Barrier sub grade recessed base cannot accumulate water and has unobstructed drainage piping and/or drainage sump pump connected and operational.		
6	Prior to Cycle Testing, inspect all barrier system components and controls are fully installed and integrated • Barrier device • Vehicle safety and traffic signal light devices • Audible alarms • Secondary control panel (CAC Guard Booth) • Primary override control panel (Post 1 Guard Booth) • Main electrical power/ Backup electrical power • Hydraulic Pump Unit (HPU) • Electro-mechanical control unit • Check and inspect all finishes		
	Cycle Testing (Minimum 3 Full Cycle Tests)		
7	**Testing procedure from Secondary Control Panel**:		

		Installer Team Lead Initials / Date	Contractor QC Manager Initials/Date
	1. Exercise Up and Down and listen for binding or rubbing. (Maximum 3-4 seconds Up)		
8	2. Check stop & go lights.		
9	3. Check open alarm. Leave the barrier in the open position. After a preset period (no more than 60 seconds) an alarm will sound from the Secondary unit and from the Primary. This timer can be set in the electrical panel adjacent to the hydraulic pump.		
10	4. Test safety loop or light curtain: a. Open the barrier and park a vehicle over the loop but not over the barrier. Attempt to close the barrier - it should not close. If safety system is tied to an adjacent gate sharing light curtains, test light curtains for operability.		
11	5. Test the emergency close function. Be sure there is no vehicle or individual standing on or immediately next to the barrier and have a safety person control the site. a. PART I: Activate the emergency close, from the open position - the barrier should snap closed (1.5 sec). Record the time. The Secondary Controller should now be inoperative and will have to be reset from the Primary Controller in Post I. b. PART II: Now park a vehicle over the safety loop but BE SURE NO PART OF THE VEHICLE IS OVER THE BARRIER. Then follow PART I sequence - The emergency close function should now override the safety loop and the sequence should be the same as for PART I.		
12	6. Cut all power to the hydraulic pump or electrical supply and test that the barrier can be operated the required minimum number of cycles using the back-up system. Record the number of cycles.		
13	7. Test that the barrier will work under generator power.		
14	8. Cut all power to the hydraulic pump or electrical supply and test that the barrier can be operated full cycle of the unit under manual function.		
	Testing procedure from Primary Control Panel		
15	9. Check same Secondary Control Panel functions 3 thru 8 above from the Primary Control Panel.		

		Installer Team Lead Initials / Date	Contractor QC Manager Initials/Date
16	10. Check reset function from Primary Control Panel.		
	Contractor's QC Manager Printed Name _____ Signature _____ Initials _____		
		Contractor's QC Manager Printed Name _____ Signature _____ Initials _____	

Noted Variances:

_____
_____
_____
_____
_____
_____
_____

DOS Approving official approval/rejection/further action indicated for each variance.

_____
_____
_____
_____
_____
_____

[1, 2]DOS Approving Official: _____Date:_____
Office:_____ Name:_____ Position:_____

[1]DOS Official acknowledgment does NOT relieve the contractor, or his subcontractor, from any requirement within the contract documents or represent approval of any hidden work.

[2]Certificate of Compliance is required to be included in the close out submittal.

SECTION 324008 – RISING BOLLARD BARRICADE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes hydraulic and electromechanical bollard barricade systems as indicated on Drawings.

B. Related Sections include the following:

1. Section 033000 "Cast-In-Place Concrete" for requirements of associated concrete work.
2. Division 09 sections for field applied finish work.
3. Division 26 and 27 sections for electrical/electronic work; including lighting, interlocks, communication systems.
4. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
5. Section 285115 “Security Management System Enterprise (SMSe).”

1.2 SUBMITTALS

A. General: All manuals, including operator, maintenance, and repair manuals are required in both printed and printable electronic formats. Along with copies required as part of Division 01 “Construction Submittals, deliver two copies of these manuals, incorporating all revisions, with system at time of commissioning. These copies shall be sent via commercial courier service to:

U.S. Department of State
Bureau of Diplomatic Security
Attn: DS/FSE/FSB – Vehicle Barrier Program Manager
SA-24 Kingstown
5800 Barclay Drive
Springfield, Virginia 22315

1. Submit copyright release for all documentation to permit reproduction and use of this material on Department of State internal automated information system networks.

B. Product data for each primary material used in fabricating custom produced elements of the work; along with manufacturer's descriptive literature for standard or customized products, fabrications, assemblies, devices, and accessory items used to produce work of this section. Include mechanical, electrical, and control data for operative and motorized units, along with spare parts listing and maintenance manuals. Include performance charts and curves. Include complete list of equipment and materials. Identify applicable industry standards and how they apply to specific components. Provide programming data, instructions and copy of software used for all PLCs.

C. Shop drawings for each type and size of customized fabrication or assembly, showing installation requirements for each element of the work of this section. Show plans, elevations, and sections at not less than 1:20 scale, and details at 1:5 scale. Shop drawings shall contain complete wiring

and schematic diagrams; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationships to the other parts of the work including foundation and clearances for maintenance and operation. Shop drawings must also indicate all applicable accessories and features that are to be provided.

D. Manufacturer's Certification: Documentation that system is tested and certified by ASTM in accordance with Article on QUALITY ASSURANCE. Certified performance compliance documentation, to the extent elements are indicated with specific performance requirements; including actual crash test reports, equivalency certifications, design/analysis calculations, and similar data suitable for the demonstration of performance achievement.

E. Previous Successful Use: Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barricade installed.

F. Test Reports: Upon completion and testing of the installed system, a test report shall be submitted in booklet form showing all fields tests, including component adjustments and demonstration of compliance with the specified performance criteria. Each test report shall indicate the final position controls.

G. [Maintenance Plan for Corrosive Environments: The manufacturer shall develop and submit a site specific routine maintenance plan tailored to local conditions and executable by the local labor force. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.]

H. [Qualifications for Work in Corrosive Environments: The contractor shall submit evidence that confirms that the bollard barricade system can and will operate in the proposed environment and will perform consistently. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.]

I. Operation and Maintenance Manuals: Submit Operation and Maintenance data in accordance with Division 01.

1. Operation instructions shall outline the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacture's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.
2. Maintenance instructions shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include piping layout, equipment layout and simplified wiring, and control diagrams of the systems as installed.

J. Spare Parts Data: After approval of the shop drawings the Contractor shall submit spare parts data for each different item of materials and equipment used. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

K. Product data for each fabricated component of the work, including product data for operating mechanism(s) and all accessory items, fasteners, and applied finishes. Include mechanical and

electrical information along with spare parts listing and maintenance manuals. Provide operating and maintenance Manuals.

L. Certificates for each type of rising bollard barricade system that individual units and assemblies have been certified by the Bureau of Diplomatic Security (DS) for use on DOS projects and achieve the required K/L rating.

M. Installation instructions shall cite all installation and connection criteria, as well as all anchorage components, including minimum embedment and minimum edge distance, and shall include alert to installers to avoid cutting of rebar during concrete anchor installation.

N. Samples for verification of factory-applied colored finish(es), other than black and white, as indicated on the Drawings.

O. Installer Qualification Data: Submit resumes of all installers documenting the installers have installed a similar barricade system within the last 5 years. The resume must include at least 3 references (including contract information) that can provide verification that the installer has the expertise required to perform a successful installation. The installer's qualifications must be approved by the Project Director/COR with input from OBO/CFSM/SM physical security engineer.

P. Durability Submittals: Submit one of the following based on Contractor's selection, and in accordance with Durability requirements in Article on PERFORMANCE REQUIREMENTS.

1. [Test Reports: Provide independent laboratory test reports using ISO/IEC 17025 (second edition) confirming the system meets the performance requirement for operating under specified number of cycles.]
2. [Warranty: Provide warranty for operability.]

Q. Training Documentation: Immediately upon completion of Operator and Supervisor training, documentation of training shall be delivered to Project Director/COR of installation. Training documentation shall include:

1. The date and time of the training.
2. A list of the names of the personnel trained.

1.3 QUALITY ASSURANCE

A. Nameplates: The vehicle barricade shall have the manufacturer's name, contact for service, and catalog or serial number permanently affixed to equipment in a suitable location.

B. Verification of Dimensions: The Contractor shall become familiar with all details of the work and verify dimensions in field as required for coordination.

C. Performance Evaluation: The barricade system shall comply with ASTM F 2656, Standard Test Method for Vehicle Crash Testing of Perimeter Barricades, latest revision. Conform to vehicle resistance standards identified in Article on PERFORMANCE REQUIREMENTS.

D. Installer Qualifications: Engage an experienced Installer who has completed in last five years a rising bollard barricade system installation similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.4 DELIVERY, STORAGE, AND HANDLING

A. To the greatest extent practicable, deliver rising bollard barricade system to project, prefabricated, assembled, equipped with accessory items, primed for painting, and ready to install. Comply with Government's criteria and manufacturer's recommendations for packaging, handling, storage, and delivery.

B. Store materials as recommended by manufacturer. Permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.5 [WARRANTY

A. Special Project Warranty:]

1. [Durability: In lieu of testing of the bollard barricade system the manufacturer may provide a 5-year comprehensive onsite material and labor warranty from Substantial Completion for any component necessary for continued operation of bollard barricade system.]
2. [Corrosion Resistance: All elements of the bollard barricade system shall be designed and constructed to resist these effects for a period of 5 years from Substantial Completion. Should corrosive damage inhibit or halt the operation of the bollard barricade system replacement parts or new bollard barricade systems shall be shipped to the project site (at no cost to the USG) and installed by qualified installers provided by the manufacturer. The government at its sole discretion may opt to install the manufacturer provided replacement parts, however this will in no way void or alter the warranty.]

1.6 EXTRA MATERIALS

A. Spare parts kit per manufacturer's recommended list.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Rising bollard barricade systems shall conform to requirements in accordance with ASTM F2656 and the OBO Zoning Code (International Zoning Code as amended by OBO).

B. Vehicle Resistance: Provide rising bollard barricade systems which are produced by manufacturers who have previously produced, within the last two years, units of similar security attack resistance of equivalent size and resistance ratings, and which have been certified by the Bureau of Diplomatic Security (DS). Required performance is for a test rating of **[M50] [M40] [M30]** per project location design via speed approach calculations with maximum vehicle penetration of P1. Provide barricade capable, in width of operation, of obstructing vehicular traffic in a minimum 4 meter (13 ft) wide traffic lane.

C. [Corrosion Resistance: When the project site is identified by OBO as being in a moderate or extreme atmospheric corrosion risk location, the components necessary for continued operation of gate systems shall be fabricated to resist corrosion.]

D. Durability: Provide rising bollard barricade systems capable of operating for 200,000 continuous cycles without failure of any component necessary for continued operation of barricade. Cycle testing shall be performed in configuration where active barricade itself is located in outdoor location that will expose unit to full sunlight and effects of climatic conditions at test facility (pollution, rain, snow, sleet, etc.). Hydraulic bollard barricade systems shall be capable of operating a minimum of 60 complete up/down cycles per hour.

E. Control Circuits: Design control system in such a way that when power fails, rising bollard barricades maintain "status quo" position. System shall fail neither secure nor safe. On rising barricade systems, provide fail-safe lock system on hydraulic cylinder or electromechanical operating system which prevents barricade from lowering in event of hydraulic or electric failure.

F. Back-up and Manual Operation: Control system shall provide back-up and manual operating capability for use in event of power failure. Back-up operating system shall provide, as a minimum, three complete cycles (up and down) without use of manual system. Manual operation of barricade shall be simple and without need of special tools or knowledge. Barricade shall be capable of being returned to secure position in manual mode in no more than 5 minutes. Battery backup systems shall be 24 to 100 volt.

G. Barricade Height: In its fully deployed, protective mode, barricade shall be minimum of “as tested” height as measured from top of foundation to top of vehicle arresting element of barricade.

H. Barricade Spacing: Provide bollard spacing no greater than “as tested” condition and with space between bollards no greater than 1200mm. Installed in a bollard line, provide no less than number of bollards with respective foundation as the “as tested” condition.

I. Serviceability: Panels and sealing features mounted on barricade shall be removable to facilitate maintenance and repair without use of specialized tools

J. Hydraulic System (if used for system): Hydraulic system shall consist of electrically driven hydraulic pump which shall pressurize high pressure manifold connected to hydraulic accumulator. Hydraulic system shall include all necessary control and logic devices, lines and valves to override and lock out normal speed control for emergence fast operation of barricade.

K. Reliability: Barricade system shall provide maximum dependability and ease of maintenance. Design system to function consistently in all DOS locations throughout the world.

L. Hydraulic Lines (if hydraulic system used): Where power and hydraulic lines are required and are below grade they must be protected with rigid electrical conduit. Where temperatures will exceed 38 degrees C (100 degrees F) for extended periods of time provide a cooling unit for the hydraulic fluid.

M. Secondary and primary controls shall have an emergency (fast operation) secure switches for each barricade. Emergency switch or switches for secondary control shall not be equipped with reset capability.

N. Environmental Protection of Hydraulic and Electrical Power Units: Environmental conditions for power units shall not exceed 30 degrees C (86 degrees F) or drop below -5 degrees C (24 degrees F). If units are placed in building space, conditions may be achieved either by using HVAC equipment for space, or by using enclosure accessory for power unit with heating and cooling unit accessories as needed to maintain environmental conditions within enclosed container. If power unit is place outdoors, provide enclosure as accessory where necessary to maintain required environmental conditions, and provide heating and cooling units as accessories as needed to maintain conditions. In addition, in locations subject to exposure to severe weather or to intensive exposure to dirt, sand, and other harmful elements, provide protection through placement in protected building space with designed features to limit harmful elements, or by placing power unit in an enclosure. Enclosure must be constructed of minimum 3mm (0.125 inch) thick plate steel and must be capable of being padlocked with a DS approved padlock.

2.2 APPROVED PRODUCTS

A. Rising Bollard Barricade Systems approved by the Bureau of Diplomatic Security may be used subject to the requirements of this specification and additional warranty requirements stated in this specification.

2.3 MATERIALS, GENERAL

A. Steel Shapes, Plates, and Bars: ASTM A 36; except where otherwise indicated, and as follows:

1. Where indicated as "high-strength" steel, provide shapes, plates, and/or bars complying with ASTM A 588, Grade C, 34.9 kg/sq. mm (50 ksi) yield strength.
2. Where indicated as tubular "high-strength" steel, provide shapes, sizes, and wall thicknesses as indicated complying with ASTM A 618, Grade Ib; 34.9 kg/sq. mm (50 ksi) yield strength.

B. Steel Finishes: Hot-dip galvanize all steel components to comply with applicable standards of ASTM A 123/A 123 M for galvanizing steel products and ASTM A 153 A, 153 M for galvanizing steel hardware. This is applicable for all active barricades.

C. Welding Rods and Bare Electrodes: Provide type recommended by AWS specifications, for the metal and alloy being welded in each element of the fabrications.

D. Bolts and Fasteners: ASTM A 320, AISI Type 300-series stainless steel bolts and nuts. Where within reach of intruders working from attack-side of facilities, including working from inside sally ports, provide non-removable bolt/nut units (not removable by use of commonly available hand tools). Provide stainless steel washers.

E. Concrete Inserts: Furnish anchorage units to be placed in concrete substrates, of hot-dip galvanized cast-iron/malleable-iron body, design/type as indicated; ASTM A 153 zinc coating, ASTM A 47 casting.

F. Setting/Anchoring Cement: Provide non-shrinking, non-staining, hydraulic-controlled expansion-type cementitious compound; factory prepackaged for mixing with water at project for a pourable and trowelable mix, recommended by manufacturer for exterior exposure (ASTM C 109).

G. Aluminum Extrusions: ASTM B 221, Alloy 6005, Temper T5 or T6; sizes, shapes, and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

H. Stainless Steel Tubing: ASTM A 269, AISI Type 304; sizes and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

I. Shop Primer Paint: Fabricator's baked-on, lead-free, modified alkyd-base, ferrous-metal primer; which is compatible with finish system specified in Division 09 painting sections, and which will provide long-term resistance to corrosion from external exposure, and form firm undercoat for field-applied topcoats after prolonged construction-period exposures. Comply with performance requirements of FS TT-P-645 and with paint manufacturer's instructions for baked-on primer coat material and application.

J. Shop Primer Paint: Organic, zinc-rich coating, with zinc-dust content not less than 80 percent by weight of non-volatile content; with vehicle base selected for compatibility with specified finish coating system. Comply with paint manufacturer's instructions for surface pretreatment materials and methods, and for primer application.

2.4 FABRICATION

A. General: Fabricate rising bollard barricade systems at the factory to greatest extent possible, including interfacing, supporting, and anchorage provisions as required for installation. Fabricate to comply with indicated performance requirements. Disassemble only to extent required for handling, delivery, and installation.

B. Provide rising bollard barricade systems that disarm all safety components of rising bollard barricade systems when in emergency mode.

C. Provide rising bollard barricade systems with all components designed and assembled by the barrier manufacturer. The entire barrier system shall be a complete kit fully warrantied by the barrier manufacturer.

D. Fabricate rising bollard barricade systems for installation as shown, flush with road surface when retracted. Include the following:

1. Provide signal light to indicate barricade status (activated or retracted) to approaching vehicle driver.
2. Provide power-operated barricade activation equipment, which is capable of fully activating the barricade in 5 seconds under normal operating conditions, and which is capable of fully activating the barricade in 1.5 seconds (for hydraulic systems) or 2 seconds (for electromechanical systems) under emergency conditions. Provide primary activation push button control station located in guard booth at barricade (secondary control unit), and overriding activation control station located at Post 1 (primary control unit) in Embassy Office Building. Operation of emergency activation at barricade requires reset of control system to retract barricade; that is possible only at Post 1.
3. Provide secondary control panel at guard booth location with open/close buttons, Emergency Fast Operation (EFO) button, and audible annunciator, which is automatically activated when barricade remains in retracted position in excess of adjustable time period, with adjustment capability up to 60 seconds. Provide either rack mounted or countertop-installed panels and coordinate selection with architectural and technical security designs; see Section 280508 “Common Work Results for Technical Security Systems (TSS).”
4. Provide primary control panel at Post 1 location with open/close buttons, Emergency Fast Operation (EFO) button and signal light, activated by operation of annunciator signal at CAC location; provide reset, which can also be used to deactivate signal at CAC. Provide rack mounted controls only; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. On dual or multiple lane sally ports or installations with more than two anti-ram barricade systems, provide custom panel that consolidates controls (separate controls and EFO’s required for each barricade; however, open barricade annunciator may be combined per sally port).
5. Provide barricade position indicator and power indicator pilot light at both control station locations.
6. Provide 24 V control circuitry of required cycles per min. rating (depends upon available power source). Provide system which retains barricade in current position when there is power failure. Provide system for back-up, such as accumulators and UPS for the controls, and for manual operation of barricade when there is power failure.
7. Equip control station at guard booth location with audible annunciator, which is automatically activated when barricade remains in retracted position in excess of adjustable time period, with adjustment capability up to 60 seconds. Equip control station at MSG booth location with signal light, activated by operation of annunciator signal at vehicular compound entry location. Provide reset, which can also be used to deactivate signal at vehicular compound entry location.
8. Provide cooling unit for hydraulic fluid of barricade operating system if unit is hydraulic.
9. Provide disconnect switch.

10. Provide limit switch (up/down).
11. Provide safety cover that closes the gap between the barricade top and pit when barricade is in the up position.
12. Electric, hydraulic, or pneumatic drive systems may be used for barricade systems.

2.5 TOUCH SCREEN CONTROL SYSTEMS

A. If selected for use on the project, provide touch screen control systems capable of the operations identified in this Article.

B. Barricade Control: Provide fabricated anti-ram rising bollard barricades that are capable of being controlled remotely from the secondary control panel (typically located within the CAC guard booth). Provide override capabilities from the Primary control panel (typically located within MSG post 1).

1. Provide units capable of being mounted in 480 mm (19”) racks or on desktop. As required, provide rack mounted controls per Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. On dual or multiple lane sally ports or installations with more than two barricades, provide a custom panel that consolidates controls (separate controls and EFOs required for each barricade; however, open (down) barricade annunciator may be combined per sally port).
2. Provide systems that have programming systems that can be adapted by end user with updated ladder logic programming from manufacturer. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).

C. Provide a secondary control panel with the following:

1. Emergency Operation (EFO) button for each barricade location (toggle switch with flip cover) (located above touchscreen and not part of the touchscreen)
2. Open (down) button
3. Close button
4. Barricade status indicator on the screen. (i.e., open, close)

    a. Visual indication light when barricade is in open (down) position.
    b. Visual indication light when barricade is in closed (up) position.
    c. Audio and visual indication signal when barricade is in open (down) position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barricade remains in the open (down) position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. The emergency switch or switches for the secondary control must not be equipped with reset capability.
7. Provide either rack mounted or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate design and selection with architectural and technical security systems design.

D. Provide a Primary control panel with the following:

1. Emergency Operation (EFO) button for each barricade location (toggle switch with flip cover) (located above touchscreen and not part of the touchscreen)
2. Open (down) button
3. Close button
4. Barricade status indicator on the screen. (i.e., open, close)

    a. Visual indication light when barricade is in open (down) position.
    b. Visual indication light when barricade is in closed (up) position.
    c. Audio and visual indication signal when barricade is in open (down) position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barricade remains in the open (down) position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. EFO reset button.
7. Capable of overriding and disabling the secondary panel.
8. Provide either rack mounted or countertop-installed panels; see Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. Coordinate design and selection with architectural and technical security systems design.

E. Provide Emergency Fast Operation (EFO) control system that overrides all safety and obstruction components of barricade when in emergency modes. Provide EFO speed per performance section.

F. Primary and secondary control panels shall not require keys for operation.

G. Primary and secondary panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections).

H. Monitor screens: Provide monitors with minimum 175 millimeter minimum (7 inch) diagonal screen size. Monitor screens shall provide clear readable views of controls in bright sunlight and glare conditions. Monitors shall be Thin Film Transistor (TFT) Liquid Chrystal Display (LCD) type, high contrast color screens, 1280 x 1024 pixels. Each monitor shall depict barricade being controlled, at top of the screen, via video input so that barricade operator can view the barricade operation via screen. Directly below view of the barricade, centered under this view, provide label of which barricade is being controlled (e.g., "Main CAC Barricade"). Text of label shall be clear and easily readable with minimum 10mm, Times New Roman Bold. Directly to left of label, locate barricade "UP" button. UP button shall be minimum of 25 mm in diameter and labeled below button "UP" with clear and easily readable, minimum 15 mm, Times New Roman Bold. Directly to right of label locate barricade "DOWN" button. DOWN button shall be minimum of 25 mm in diameter and labeled below button "DOWN" with clear and easily readable, minimum 15 mm, Times New Roman Bold.

I. System processing control unit:

1. Self-diagnostic systems: Provide barricade control systems capable of self-diagnosis. Minimum features required are:

a. Audit Trail: Provide audit trail of up, down, EFO, interlock, and reset functions of barricade that is easily user interpreted.
b. Cycle counter: Provide cycle counter that records each cycle of barricade. Provide barricade cycle counter in barricade and in control system. Cycle counter in barricade unit shall be readily visible to maintenance staff monitoring barricade.
c. Lifecycle Function: Lifecycle function that alerts maintenance staff of required or upcoming necessary maintenance.
d. Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 "Security Management System Enterprise (SMSe)." Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System shall require user ID and Password for access to secure connection.
e. Troubleshooting: Provide systems that have troubleshooting function. Troubleshooting function shall contain standardized code system or language that is consistent for each of manufacturer's barricade systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.
f. Pressure monitoring meter: Provide pressure monitoring meter on hydraulic and pneumatic units. Provide low pressure alarm to warn when pressure has dropped below 4.14 MPa (600 PSI) in unit.
g. Low oil level monitor: Provide monitor that warns barricade operator when oil level in unit is low.

2. Equipment and components: Provide only programmable logic controllers (PLCs) and other components that are compatible with RS232 and CAT 5 technologies.
3. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting unit or inadvertently triggering system.
4. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.6 PUSH BUTTON CONTROL SYSTEMS

A. If selected for use on the project, provide push button control systems capable of operations identified in this Article.

B. Barricade Control: Provide fabricated anti-ram rising bollard barricades that are capable of being controlled remotely from the secondary control panel (typically located within the CAC guard booth). Provide override capabilities from the Primary control panel (typically located within MSG post 1).

1. Provide units capable of being mounted in 480 mm (19 inch) racks or on desktop. As required, provide rack mounted controls per; Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. On dual or multiple lane sally ports or installations with more than two barricades provide a custom panel that consolidates controls (separate controls and EFOs required for each barricade; however, open (down) barricade annunciator may be combined per sally port).

2. Provide systems that have programming systems that can be adapted by end user with updated ladder logic programming from manufacturer. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).

C. Provide a secondary control panel with the following:

1. Emergency Operation (EFO) button for each barricade location (toggle switch with flip cover)
2. Open (down) button (green) minimum 22 mm diameter
3. Close button (red) minimum 22 mm diameter
4. Barricade status indicator light. (i.e., open, close)

   a. Visual indication light when barricade is in open (down) position.
   b. Visual indication light when barricade is in closed (up) position.
   c. Audio and visual indication signal when barricade is in open (down) position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barricade remains in the open (down) position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. The emergency switch or switches for the secondary control must not be equipped with reset capability.
7. Provide either rack mounted or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate design and selection with architectural and technical security systems design.

D. Provide a Primary control panel with the following:

1. Emergency Operation (EFO) button for each barricade location (toggle switch with flip cover)
2. Open (down) button (green) minimum 22 mm diameter
3. Close button (red) minimum 22 mm diameter
4. Barricade status indicator light. (i.e., open, close)

   a. Visual indication light when barricade is in open (down) position.
   b. Visual indication light when barricade is in closed (up) position.
   c. Audio and visual indication signal when barricade is in open (down) position for more than 60 seconds.

5. Audible annunciator, which is automatically activated when barricade remains in the open (down) position in excess of adjustable time period, with adjustment capability up to 60 seconds.
6. EFO reset button (black) minimum 22 mm diameter.
7. Capable of overriding and disabling the secondary panel with turn switch (on/off).
8. Provide either rack mounted or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate design and selection with architectural and technical security systems design.

E. Provide Emergency Fast Operation (EFO) control system that overrides all safety and obstruction components of barricade when in emergency modes. Provide EFO speed per performance section.

F. Primary and secondary control panels shall not require keys for operation.

G. Primary and secondary panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections).

H. System processing control unit:

1. Self-diagnostic systems: Provide barricade control systems capable of self-diagnosis. Minimum features required are:

   a. Audit Trail: Provide audit trail of up, down, EFO, interlock and reset functions of barricade that is easily user interpreted.
   b. Cycle counter: Provide cycle counter that records each cycle of barricade. Provide barricade cycle counter in barricade and in control system. Cycle counter in barricade unit shall be readily visible to maintenance staff monitoring barricade.
   c. Lifecycle Function: Lifecycle function that alerts maintenance staff of required or upcoming necessary maintenance.
   d. Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 “Security Management System Enterprise (SMSe).” Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System shall require user ID and Password for access to secure connection.
   e. Troubleshooting: Provide systems that have troubleshooting function. Troubleshooting function shall contain standardized code system or language that is consistent for each of manufacturer’s barricade systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.
   f. Pressure monitoring meter: Provide pressure monitoring meter on hydraulic and pneumatic units. Provide low pressure alarm to warn when pressure has dropped below 4.14 MPa (600 PSI) in unit.
   g. Low oil level monitor: Provide monitor that warns barricade operator when oil level in unit is low.

2. Equipment and components: Provide only programmable logic controllers (PLCs) and other components that are compatible with RS232 and CAT 5 technologies.
3. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting unit or inadvertently triggering system.
4. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.7 ACCESSORIES

A. Remote control panel with annunciator, override and reset.

B. Emergency Manual Operation: Provide hand pump to allow barricade to be raised manually in event of prolonged power interruption.

C. Emergency fast operation.

D. Low fluid level switch.

E. Sump Pump: Provide self-priming sump pump to drain water collected in barricade foundation. Pump shall have capacity to remove maximum expected rainfall per minute a distance of 5 meters to discharge drain. Pump operating voltage shall be 240 volts, 1 Phase, 50 Hertz.

F. Export packaging.

G. Electrical disconnect at the hydraulic unit.

H. Uninterrupted Power Supply (UPS) for the primary and secondary control panels.

I. Safety Interlock Detector: A bollard vehicle detector safety loop shall be supplied to prevent the bollard from being accidentally raised under an authorized vehicle. The detector shall utilize digital logic and have fully automatic tuning for stable and accurate long-term reliability. The output of the detector shall delay any bollard rise signal (except for Emergency Fast Operation command) when a vehicle is over the loop.

J. [Power unit enclosure where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS. The steel enclosure shall be minimum of 2 mm thick steel and provided with DS approved padlock. Enclosure may be custom fabricated if not a standard accessory from power unit manufacturer.]

K. [Heating unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]

L. [Cooling unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]

2.8 FABRICATION

A. General: Fabricate rising bollard barricade systems at the factory to the greatest extent possible, including interfacing, supporting, and anchorage provisions as required for installation. Fabricate to comply with indicated performance requirements. Disassemble only to the extent required for handling, delivery, and installation.

1. Provide rising bollard barricade system that disarms all safety components of active barricade systems when in emergency mode.
2. Provide rising bollard barricade system with all components designed and assembled by the barrier manufacturer. The entire barrier system shall be a complete kit fully warrantied by the barrier manufacturer.

B. Fabricate rising bollard barricade systems for installation as shown, flush with road surface when retracted. Include the following:

1. Provide power-operated barricade activation equipment, which is capable of fully activating barricade in 5 seconds under normal operating conditions, and which is capable of fully activating barricade in 1.5 seconds under emergency conditions. Provide primary activation push button control station located in guard booth at barricade (secondary control unit), and overriding activation control station located at Post 1 (primary control unit) in Embassy Office Building. Operation of emergency activation at barricade requires reset of control system in order to retract barricade; that is possible only at Post 1.
2. Provide secondary control panel at guard booth location with open/close buttons, Emergency Fast Operation (EFO) button (two stage button, see paragraph on "Emergency Fast Operation Button (EFO)" and audible annunciator, which is automatically activated when barricade remains in retracted position in excess of adjustable time period, with adjustment capability up to 60 seconds. Provide either rack mounted or countertop installed panels and coordinate selection with the architectural and technical security designs; see Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks.
3. Provide primary control panel at Post 1 location with open/close buttons, Emergency Fast Operation (EFO) button and signal light, activated by operation of annunciator signal at CAC location; provide reset, which can also be used to deactivate signal at CAC. Provide rack mounted controls only; see Section 280508 "Common Work Results for Technical Security Systems (TSS)" for racks. On dual or multiple lane sally ports or installations with more than two anti-ram barricades provide a custom panel that consolidates controls (separate controls and EFO's required for each barricade; however, open barricade annunciator may be combined per sally port).
4. Provide barricade position indicator and power indicator pilot light at both control station locations.
5. Provide 24 V control circuitry of required cycles per min. rating (depends upon available power source). Provide system which retains barricade in current position when there is power failure. Provide system for back-up, such as accumulators and UPS for the controls, and for manual operation of barricade when there is power failure.
6. Equip control station at MSG guard booth location with audible annunciator, which is automatically activated when barricade remains in retracted position in excess of adjustable time period, with adjustment capability up to 60 seconds. Equip control station at MSG booth location with signal light, activated by operation of annunciator signal at vehicular compound entry location. Provide reset, which can also be used to deactivate signal at vehicular compound entry location.
7. Provide cooling unit for hydraulic fluid of barricade operating system if unit is hydraulic.
8. Provide disconnect switch.
9. Provide limit switch (up/down).
10. Provide safety cover that closes the gap between the barricade top and pit when barricade is in the up position.
11. Electric, hydraulic, or pneumatic drive systems may be used for barricade systems.

PART 3 - EXECUTION

3.1 EXAMINATION, COORDINATION, PREPARATION

A. General: Examine substrate work, being prepared as work of other sections, for the anchorage and support of rising bollard barricade system of this section. Deliver anchorage inserts, sleeves, and other elements to be cast in concrete work, prior to time scheduled for placement of concrete. Furnish instructions, setting diagrams, templates, and/or other information for elements to be installed as work of other sections. Set posts, frames and similar elements plumb, level and true to line and location, and support adequately during placement of concrete.

B. Examine prefabricated units, and preparations made and to be made as work of other Sections and confirm that interfaces and support of work of this section will achieve performances and align within installation tolerances.

C. Coordinate installation of rising bollard barricade system with installation of related work, to ensure optimum sequencing of interfaces.

3.2 INSTALLATION

A. Comply with fabricator's instructions for the handling, protection, assembly, installation, anchorage, and other required interface connections of rising bollard barricade system with other work. Set level and plumb, true to line and location. Anchor to develop full-strength resistances against attacks.

3.3 TESTING AND ADJUSTING

A. Test operate each set of bollards through repeated cycles of operation, and test operation, controls, safety devices, signals, and other features to Project Director/COR. Provide adjustments as requested to comply with requirements and intended cycles of use and operation.

B. Instructions for testing bollard barricade system from Secondary Control Panel

1. Exercise Up and Down and listen for binding or rubbing.
2. Check open alarm. Leave barricade in the down position. After preset period (no more than one minute) an alarm will sound from secondary unit and from primary. This timer can be set in electrical panel adjacent to hydraulic pump.
3. Test safety loop or light curtain:

   a. Lower barricade and park vehicle over loop but not over barricade. Attempt to raise barricade - it should not rise. If safety system is tied to an adjacent gate sharing light curtains, test light curtains for operability.

4. Test emergency up function. Be sure there is no vehicle or individual standing on or immediately next to barricade and have safety person control site.

a. PART I: Activate emergency up, from down position - barricade should snap up (1.5sec); record time. Secondary controller should now be inoperative and will have to be reset from primary controller in Post I.
b. PART II: Now park vehicle over safety loop but BE SURE NO PART OF VEHICLE IS OVER BARRICADE. Then follow Part I sequence - Emergency up function should now override safety loop and sequence should be same as for Part I.

5. Cut all power to hydraulic pump and test that barricade can be operated required number of cycles using back-up system. Record number of cycles.
6. Cut all power to hydraulic pump or electrical supply and that barricade can be operated full cycle of unit under manual function.
7. Have contractor demonstrate that barricades and controls will work under generator power.

C. Instructions for testing bollard barricade system from Primary Control Panel

1. Check functions 1 thru 5 and 8 above from primary.
2. Check reset function from primary.

3.4 CLEANING AND FINISHING

A. Clean exposed surfaces of rising bollard barricade system, including primed surfaces and finished surfaces, exercising care to avoid damage to finishes; touch up minor blemishes in finished surfaces.

B. Refer to Division 09 Section painting Sections for application of field-applied finish coatings over shop-applied primer coatings; not work of this section.

3.5 MANUFACTURER'S SERVICE

A. Services of a manufacturer's representative who is experienced in installation, adjustment, and operation of equipment supplied shall be available. The representative shall supervise installation, adjustment, and testing of equipment.

3.6 TRAINING

A. Operator Training: Manufacturers' representative shall provide initial Operator training to Local Guard Force (LGF) personnel. Training shall be delivered at post of installation within one business day following commissioning of the new system. Initial Operator training shall include:

1. Overview of system.
2. Essential controls and displays.
3. Safety precautions.

B. Supervisor Training: Manufacturer's representative shall provide initial Supervisor training for Regional Security Officer (RSO) or designated representative, LGF supervisor, and others as

identified by RSO. This training shall be delivered at post of installation within one business day following commissioning of new system. Initial Supervisor training shall include:

1. Overview of system.
2. Understanding of system's purpose and capabilities.
3. Essential controls and displays.
4. Safety precautions.

C. Maintenance Training: Manufacturer or representative shall provide Maintenance training, including MANUFACTURER'S CERTIFICATION TRAINING to level of "Factory Authorized Technician" status at manufacturer's facility for following personnel:

1. Two instructional personnel from DS/SECD/TTB.
2. One instructional designer from DS/TPS/ISM.
3. One DS/C/ST subject matter expert (SME).
4. One person from OBO/CFSM/SM/SCD/TSB.

D. Manufacturer shall provide no less than two additional spaces per each Maintenance training class and/or training at their manufacturing facility for other DOS-designated personnel. This training shall encompass all aspects of operations, maintenance, safety and repair.

E. Maintenance training shall enable personnel listed in this section to perform routine maintenance and inspection requirements, in compliance with manufacturers' requirements.

F. Manufacturer shall make available annual refresher or re-certification Maintenance training for personnel identified in Paragraph on "Maintenance Training."

G. System upgrades that require more than four hours for operator accommodation shall require operator and supervisor training as specified in this specification as for new system.

END OF SECTION 324008

SECTION 324009 - CRASH-RATED DROP ARM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this section includes, but is not necessarily limited to, the following elements as indicated on Drawings in and around the gatehouse at entrance/exit gate locations:

1. Crash-rated drop arm barriers for passage of vehicles, in and out of the project site, on and off the post.
2. Use of these systems is limited to seldom utilized secondary compound egress points with prior approval of the Project Director/COR with input from OBO/CFSM/SM physical security engineer.

B. Related Sections include the following:

1. Section 033000 "Cast-In-Place Concrete" for requirements of concrete foundations for drop arms.
2. Section 055005 “Metal Fabrications” for structural steel and metal fabrications required at entrance/exit locations.
3. Division 09 sections for field applied finish work at entrance/exit gate locations.
4. Division 26 and 27 sections for electrical/electronic work; including lighting, interlocks, communication systems.
5. Section 280508 “Common Work Results for Technical Security Systems (TSS).”
6. Section 285115 “Security Management System Enterprise (SMSe)” related to monitoring interface.

1.2 SUBMITTALS

A. General: All manuals, including operator, maintenance, and repair manuals are required in both printed and printable electronic formats. Along with copies required as part of Division 01 “Construction Submittals,” deliver two copies of these manuals, incorporating all revisions, with system at time of commissioning. These copies shall be sent via commercial courier service to:

U.S. Department of State
Bureau of Diplomatic Security
Attn: DS/FSE/FSB – Vehicle Barrier Program Manager
SA-24 Kingstown
5800 Barclay Drive
Springfield, Virginia 22315

1. Submit copyright release for all documentation to permit reproduction and use of this material on Department of State internal automated information system networks.

B. Product data for each primary material used in fabricating custom produced elements of the work; along with manufacturer's descriptive literature for standard or customized products, fabrications, assemblies, devices, and accessory items used to produce work of this section. Include mechanical, electrical, and control data for operative and motorized units, along with spare parts listing and maintenance manuals. Include performance charts and curves. Include complete list of equipment and materials. Identify applicable industry standards and how they apply to specific components. Include installation instructions.

C. Shop drawings for each type and size of customized fabrication or assembly, showing installation requirements for each element of the work of this section. Show plans, elevations, and sections at not less than 1:20 scale, and details at 1:5 scale. Shop drawings shall contain complete wiring and schematic diagrams; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationships to the other parts of the work including foundation and clearances for maintenance and operation. Shop drawings must also indicate all applicable accessories and features that are to be provided.

D. Manufacturer’s Certification: Documentation that system is tested and certified by ASTM in accordance with article on QUALITY ASSURANCE. Certified performance compliance documentation, to the extent elements are indicated with specific performance requirements; including actual crash test reports, equivalency certifications, design/analysis calculations, and similar data suitable for the demonstration of performance achievement.

E. Previous Successful Use: Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.

F. Test Reports: Upon completion and testing of the installed system, a test report shall be submitted in booklet form showing all fields tests, including component adjustments and demonstration of compliance with the specified performance criteria. Each test report shall indicate the final position controls.

G. [Maintenance Plan for Corrosive Environments: The manufacturer shall develop and submit a site specific routine maintenance plan tailored to local conditions and executable by the local labor force. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.]

H. [Qualifications for Work in Corrosive Environments: The contractor shall submit evidence that confirms that the drop arm system can and will operate in the proposed environment and will perform consistently. Submit when requirements for Corrosion Resistance in Article on PERFORMANCE REQUIREMENTS are applicable.]

I. Operation and Maintenance Manuals: Submit Operation and Maintenance data in accordance with Division 01.

1. Operation instructions shall outline the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacture’s name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

2. Maintenance instructions shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include piping layout, equipment layout and simplified wiring, and control diagrams of the systems as installed.

J. Spare Parts Data: After approval of the shop drawings the Contractor shall submit spare parts data for each different item of materials and equipment used. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

K. Installer Qualification Data: Submit resumes of all installers documenting the installers have installed the same crash-rated drop arm systems for a DOS project with the last 5 years. The resume must include at least 3 references (including contract information) that can provide verification that the installer has the expertise required to perform a successful installation. The installer's qualifications must be approved by Project Director/COR with input from OBO/CFSM/SM physical security engineer.

L. Durability Submittals: Submit one of the following based on Contractor's selection, and in accordance with Durability requirements in Article on PERFORMANCE REQUIREMENTS.

1. [Test Reports: Provide independent laboratory test reports using ISO/IEC 17025 (second edition) confirming the gate system meets the performance requirement for operating under specified number of cycles.]
2. [Warranty: Provide warranty for operability.]

M. Training Documentation: Immediately upon completion of Operator and Supervisor training, documentation of training shall be delivered to Project Director/COR of installation. Training documentation shall include:

1. The date and time of the training.
2. A list of the names of the personnel trained.

1.3 QUALITY ASSURANCE

A. Nameplates: The crash-rated drop arm systems shall have the manufacturer's name, contact for service, and catalog or serial number permanently affixed to a plate securely attached to the equipment in a suitable location.

B. Verification of Dimensions: The Contractor shall become familiar with all details of the work, and verify dimensions in the field as required for coordination.

C. Performance Evaluation: Drop arm system shall comply with ASTM F 2656, Standard Test Method for Vehicle Crash Testing of Perimeter Barriers, latest revision. Conform to vehicle resistance standards identified in Article on PERFORMANCE REQUIREMENTS.

D. Installer Qualifications: Engage experienced Installer who has completed in last five years a crash-rated drop arm system installation similar in material, design, and extent to that indicated for this Project and with record of successful in-service performance.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver elements of the perimeter gate facilities to the project with assemblies prefabricated, prefinished, and equipped with devices and accessories to the greatest extent possible. Comply with Government's criteria for packaging, handling, protection, storage, and delivery.

1.5 [WARRANTY

A. Special Project Warranty:]

1. [Durability: In lieu of testing of the drop arm system the manufacturer may provide a 5-year comprehensive on site material and labor warranty from Substantial Completion for any component necessary for continued operation of the gate system.]

2. [Corrosion Resistance: All elements of the drop arm system shall be designed and constructed to resist these effects for a period of 5 years from Substantial Completion. Should corrosive damage inhibit or halt the operation of the drop arm system replacement parts or new gate systems shall be shipped to the project site (at no cost to the USG) and installed by qualified installers provided by the manufacturer. The government at its sole discretion may opt to install the manufacturer provided replacement parts, however this will in no way void or alter the warranty.]

1.6 EXTRA MATERIALS

A. Spare parts kit per manufacturer's recommended list.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide crash-rated drop arm systems in accordance with ASTM F2656 and the OBO Zoning Code (International Zoning Code as amended by OBO).

B. Vehicle Resistance: Provide Crash-rated drop arm systems which are produced by manufacturers who have previously produced, within the last two years, units of similar security attack resistance of equivalent size and resistance ratings, and which are certified by the Bureau of Diplomatic Security (DS). Required performance is for a test rating of **[M50] [M40] [M30]** per project location design via speed approach calculations with maximum vehicle penetration of P1. Provide drop arm capable, in width of operation, of obstructing vehicular traffic in a 4 meter (13 ft) wide traffic lane.

C. [Corrosion Resistance: When the project site is identified by OBO as being in a moderate or extreme atmospheric corrosion risk location, the components necessary for continued operation of crash-rated drop arm systems shall be fabricated to resist corrosion.]

D. Durability: Provide crash-rated drop arm systems capable of operating for 200,000 continuous cycles without failure of any component necessary for continued operation of systems. Cycle testing shall be performed in a configuration where active barrier itself is located in outdoor location that will expose the unit to full sunlight and effects of climatic conditions at test facility (pollution, rain, snow, sleet, etc.). Crash-rated drop arm systems shall be capable of operating a minimum of 60 complete up/down cycles per hour.

E. Status Indicators: Drop arm system shall provide clearly visible device, such as signal light or drop arm, to indicate barrier's status to approaching driver.

F. Control Circuits: Design control system in such a way that when power fails barriers maintain "status quo" position. System shall fail neither secure nor safe. On hydraulic barrier systems, provide fail-safe lock system on hydraulic cylinder which prevents barrier from lowering in event of hydraulic failure.

G. Back-up and Manual Operation: Control system shall provide back-up and manual operating capability for use in event of power failure. Back-up operating system shall provide, as a minimum, three complete cycles (open and shut) without the use of manual system. Manual operation of barrier shall be simple and without need of special tools or knowledge. Barrier shall be capable of being returned to secure position, in manual mode, in no more than 5 minutes. Battery backup systems shall be 24 to 100 volt or less, systems.

H. Reliability: Barrier system shall provide maximum dependability and ease of maintenance. System shall be designed to function consistently in all DOS locations throughout world.

I. Hydraulic Lines: Where power and hydraulic lines are required and are below grade, they shall be protected with rigid electrical conduit. Where temperatures will exceed 38 degrees C (100 degrees F) for extended periods of time, provide cooling unit for hydraulic fluid.

J. Secondary and primary controls shall have emergency (fast operation) secure switches for each barrier. Emergency switch or switches for secondary control shall not be equipped with reset capability.

K. Environmental Protection of Power Units: Environmental conditions for power units shall not exceed 30 degrees C (86 degrees F) or drop below -5 degrees C (24 degrees F). If units are placed in building space, conditions may be achieved either by using HVAC equipment for space, or by using an enclosure accessory for power unit with heating and cooling unit accessories as needed to maintain the environmental conditions within enclosed container. If power unit is place outdoors, provide enclosure as accessory where necessary to maintain required environmental conditions, and provide heating and cooling units as accessories as needed to maintain conditions. In addition, in locations subject to exposure to severe weather or to intensive exposure to dirt, sand, and other harmful elements, provide protection through placement in protected building space with designed features to limit harmful elements, or by placing power unit in enclosure. Enclosure must be constructed of minimum 3 mm (0.125 inch) thick plate steel and must be capable of being padlocked with a DS approved padlock.

2.2 MATERIALS, GENERAL

A. Steel Shapes, Plates, and Bars: ASTM A 36; except where otherwise indicated, and as follows:

1. Where indicated as "high-strength" steel, provide shapes, plates, and/or bars complying with ASTM A 588, Grade C, 34.9 kg/sq. mm (50 ksi) yield strength.
2. Where indicated as tubular "high-strength" steel, provide shapes, sizes, and wall thicknesses as indicated complying with ASTM A 618, Grade Ib; 34.9 kg/sq. mm (50 ksi) yield strength.

B. Steel Finishes: Hot-dip galvanize all steel components to comply with applicable standards of ASTM A 123/A 123 M for galvanizing steel products and ASTM A 153 A, 153 M for galvanizing steel hardware. This is applicable for all active barriers.

C. Welding Rods and Bare Electrodes: Provide type recommended by AWS specifications, for metal and alloy being welded in each element of fabrications.

D. Bolts and Fasteners: ASTM A 320, AISI Type 300-series stainless steel bolts and nuts. Where within reach of intruders working from attack-side of facilities, including working from inside sally ports, provide non-removable bolt/nut units (not removable by use of commonly available hand tools). Provide stainless steel washers.

E. Concrete Inserts: Furnish anchorage units to be placed in concrete substrates, of hot-dip galvanized cast-iron/malleable-iron body, design/type as indicated; ASTM A 153 zinc coating, ASTM A 47 casting.

F. Setting/Anchoring Cement: Provide non-shrinking, non-staining, hydraulic-controlled expansion-type cementitious compound; factory prepackaged for mixing with water at project for a pourable and trowelable mix, recommended by manufacturer for exterior exposure (ASTM C 109).

G. Aluminum Extrusions: ASTM B 221, Alloy 6005, Temper T5 or T6; sizes, shapes, and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

H. Stainless Steel Tubing: ASTM A 269, AISI Type 304; sizes and wall thicknesses as indicated or, where not otherwise indicated, as required to achieve performances indicated.

I. Shop Primer Paint: Fabricator's baked-on, lead-free, modified alkyd-base, ferrous-metal primer; which is compatible with finish system specified in Division 09 Sections on painting and coatings, and which will provide long-term resistance to corrosion from external exposure, and form a firm undercoat for field-applied topcoats after prolonged construction-period exposures. Comply with performance requirements of FS TT-P-645 and with paint manufacturer's instructions for baked-on primer coat material and application.

J. Shop Primer Paint: Organic, zinc-rich coating, with zinc-dust content not less than 80% by weight of non-volatile content; with vehicle base selected for compatibility with specified finish coating system. Comply with paint manufacturer's instructions for surface pretreatment materials and methods, and for primer application.

2.3 FABRICATION

A. General: Fabricate crash-rated drop arm systems at factory to greatest extent possible, including interfacing, supporting, and anchorage provisions as required for installation. Fabricate to comply with indicated performance requirements. Disassemble only to extent required for handling, delivery, and installation.

1. Provide crash-rated drop arm systems that disarm all safety components of crash-rated drop arm system when in emergency mode.

B. Fabricate crash-rated drop arm systems for installation as shown, flush with road surface when retracted. Include the following:

1. Provide signal light to indicate barrier status (activated or retracted) to approaching vehicle driver.
2. Provide power-operated barrier activation equipment, which is capable of fully activating the barrier in 5 seconds under normal operating conditions, and which is capable of fully activating the barrier in 1.5 seconds under emergency conditions.
3. Provide primary activation push button control station located in guard booth at drop arm (secondary control unit),and overriding activation control station located at Post 1 (primary control unit) in the Embassy Office Building. Operation of the emergency activation at the drop arm requires a reset of the control system in order to retract the barrier; and that is possible only at Post 1.
4. Provide a secondary control panel at guard booth location with open/close buttons, Emergency Fast Operation (EFO) button and an audible annunciator, which is automatically activated when barrier remains in up position in excess of adjustable time period, with adjustment capability up to 60 seconds. Provide either rack mounted or countertop-installed panels; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. Coordinate selection with the architectural and technical security designs.
5. Provide a primary control panel at Post 1 location with open/close buttons, Emergency Fast Operation (EFO) button and signal light, activated by operation of annunciator signal at CAC location; provide reset, which can also be used to deactivate signal at CAC. Provide rack mounted controls only; see Section 280508 “Common Work Results for Technical Security Systems (TSS)” for racks. On dual or multiple lane sally ports or installations with more than two anti-ram barriers provide a custom panel that consolidates controls (separate controls and EFO’s required for each barrier; however, open barrier annunciator may be combined per sally port).
6. Provide barrier position indicator and power indicator pilot light at both control station locations.
7. Provide 24 V control circuitry of the required cycles per min. rating (depends upon available power source). Provide system which retains barrier in current position when there is a power failure. Provide a system for back-up, such as accumulators and UPS for the controls, and for manual operation of barrier when there is a power failure.
8. Equip control station at MSG guard booth location with audible annunciator, which is automatically activated when drop arm remains in retracted position in excess of adjustable time period, with adjustment capability up to 60 seconds. Equip control station at MSG

booth location with signal light, activated by operation of annunciator signal at gatehouse location. Provide reset, which can also be used to deactivate signal at gatehouse location.

9. Provide cooling unit for the hydraulic fluid of the drop arm operating system if unit is hydraulic. Provide disconnect switch.
10. Provide limit switch (up/down).
11. Provide safety cover that closes the gap between the barrier top and pit when barrier is in the up position.
12. Electric, hydraulic, or pneumatic drive systems may be used for drop arm systems.

2.4 CONTROL SYSTEMS

A. Provide touch screen control systems capable of the following:

1. Provide systems that have programming systems that are editable by end user. Systems shall be capable of being rebooted in no more than 60 seconds. Systems shall provide protection from Solar Maximum events and provide shielding from electromagnetic interference (EMI).
2. Provide units capable of being mounted in 480mm (19 inch) racks or on desktop.
3. Up/down control buttons.
4. Emergency Fast Operate Button (EFO): EFO button shall be separate physical two stage button. Each barrier shall have its own EFO button.
5. Status Lights: Provide barrier status indicators that indicate:

    1) Visual indication light when barrier is in up position.
    2) Visual indication light when barrier is in down position.
    3) Audio and visual indication signal when barrier is in up position for more than 60 seconds.

6. Primary controller: Provide primary control system in Post 1 or the Security Control Center (SCC). Primary control panel shall be capable of overriding secondary panels. Panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections); custom made control panel units are not permitted. Primary control panel shall not require keys for operation.
7. Secondary controller: Provide secondary control system in vehicle control booths of CAC's or other facilities. Secondary control systems shall be capable of being overridden by Post 1 or the SCC. Panels shall be of standard design and easily interchangeable (quick connect/reconnect non-solder type connections); custom made control panel units are not permitted. Secondary control panel shall not require keys for operation.
8. Interlocking functions: Provide control systems capable of locking out barrier down operation when vehicle gates located on the protected side of sallyport are in open position. Provide two stage button override control of interlocking feature at Post 1 or SCC.
9. Self-diagnostic systems: Provide barrier control systems capable of self-diagnosis. Minimum features required are:

    1) Audit Trail: Provide audit trail of up, down, EFO, interlock and reset functions of barrier that is easily user interpreted.

2) Cycle counter: Provide cycle counter that records each cycle of barrier. Provide barrier cycle counter in barrier and in control system. Cycle counter in barrier unit shall be readily visible to maintenance staff monitoring barrier.
3) Lifecycle Function: Lifecycle function that alerts maintenance staff of required or upcoming necessary maintenance.
4) Diagnostic Systems: Provide diagnostic systems capable of reporting through DOS SMSe monitoring network system; see Section 285115 "Security Management Systems Enterprise (SMSe)" regarding that system. Provide systems capable of providing secure (HTTPS) remote access connections with SMSe network. System shall require a user ID and Password for access to secure connection.
5) Troubleshooting: Provide systems that have a troubleshooting function. Troubleshooting function shall contain standardized code system or language that is consistent for each of manufacturer's barrier systems. Troubleshooting systems shall not have remote manufacturer maintenance and diagnostic capabilities.
6) Pressure monitoring meter: Provide pressure monitoring meter on hydraulic and pneumatic units. Provide low pressure alarm to warn when pressure has dropped below 4.14 MPa (600 PSI)) in unit.
7) Low oil level monitor: Provide monitor that warns barrier operator when oil level in unit is low.

10. Monitor screens: Provide monitors with minimum 175 mm (7 inch) minimum screen size. Monitor screens shall provide clear readable views of controls in bright sunlight and glare conditions. Monitors shall be Thin Film Transistor (TFT) Liquid Chrystal Display (LCD) type, high contrast color screens, 1280 x 1024 pixels. Each monitor shall depict barrier being controlled, at top of the screen, via video input so that barrier operator can view barrier operation via screen. Directly below view of barrier, centered under this view, provide label of which barrier is being controlled (e.g., "Main Gate Barrier"). Text of label shall be clear and easily readable with a minimum font size of 24 point, Times New Roman Bold. Directly to left of label, locate barrier "UP" button. UP button shall be minimum of 20 mm in diameter and labeled below button "UP" with clear and easily readable, minimum 32 point font, Times New Roman Bold. Directly to right of label, locate barrier "DOWN" button. DOWN button shall be minimum of 20 mm in diameter and labeled below button "DOWN" with clear and easily readable, minimum 24 point font, Times New Roman Bold.
11. Standardized controllers: Provide controllers capable of operating up to two barriers and two gates per controller unit.
12. Equipment and components: Provide only programmable logic controllers (PLC's) and other components that are compatible with RS232 and CAT 5 technologies.
13. Control systems frame: Provide control systems housings (frames) fabricated such that interior components can be removed without short circuiting the unit or inadvertently triggering system.
14. Spare modules: Provide one spare module for each type of module used in each controller provided.

2.5 ACCESSORIES

A. Remote control panel with annunciator, override and reset.

B. Emergency Manual Operation: Provide hand pump to allow barrier to be raised and lowered manually in event of prolonged power interruption.

C. Emergency fast operation.

D. Low fluid level switch.

E. Power off operation.

F. Sump pump (in ground units)

G. Export packaging.

H. Electrical disconnect at the hydraulic unit.

I. Uninterrupted Power Supply (UPS) for the primary and secondary control panels.

J. Safety Interlock Detector: Provide drop arm detector safety loop to prevent drop arm from being accidentally lowered onto an authorized vehicle. Detector shall utilize digital logic and have fully automatic tuning for stable and accurate long-term reliability. Output of detector shall delay any barrier rise signal (except for Emergency Fast Operation command) when vehicle is over loop.

K. [Power unit enclosure where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS. The steel enclosure shall be minimum of 2 mm thick steel and provided with DS approved padlock. Enclosure may be custom fabricated if not a standard accessory from power unit manufacturer.]

L. [Heating unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]

M. [Cooling unit for power supply where required for environmental protection of power supply; see Article on PERFORMANCE REQUIREMENTS.]

PART 3 - EXECUTION

3.1 EXAMINATION, COORDINATION, PREPARATION

A. General: Examine substrate work, being prepared as work of other sections, for the anchorage and support of crash-rated drop arm systems of this section. Deliver anchorage inserts, sleeves, and other elements to be cast in concrete work, prior to time scheduled for placement of concrete. Furnish instructions, setting diagrams, templates, and/or other information for elements to be

installed as work of other sections. Set frames and similar elements plumb, level and true to line and location; and support adequately during placement of concrete.

B. Examine prefabricated units, and preparations made and to be made as work of other Sections and confirm that interfaces and support of work of this section will achieve performances and align within installation tolerances.

C. Coordinate installation of crash-rated drop arm systems with installation of related work, to ensure optimum sequencing of interfaces.

3.2 INSTALLATION

A. Comply with fabricator's instructions for the handling, protection, assembly, installation, anchorage, and other required interface connections of crash-rated drop arm with other work. Set level and plumb, true to line and location. Anchor to develop full-strength resistances against attacks and forced-entry attempts.

1. Comply with manufacturer's instructions for the installation of crash-rated drop arm systems as shown; and for the mechanical/electrical interconnection of power and control elements.

3.3 TESTING AND ADJUSTING

A. Test operate each active crash-rated drop arm system operational unit through repeated cycles of operation; and demonstrate operation, controls, safety devices, signals, and other features to Project Director/COR. Provide adjustments as requested to comply with requirements and intended cycles of use and operation.

B. Instructions for testing crash-rated drop arm systems from Secondary Control Panel.

1. Exercise Up and Down while listening for binding or rubbing.
2. Check stop & go lights.
3. Check open alarm. Leave the barrier in open position. After preset period (no more than one minute), an alarm will sound from secondary unit and from primary. This timer can be set in electrical panel adjacent to hydraulic pump.
4. Test safety loop:

   a. Open barrier and park a vehicle over loop but not under barrier. Attempt to close barrier - it should not close. If safety system is tied to an adjacent gate sharing light curtains, test light curtains for operability.

5. Test emergency close function. Ensure there is no vehicle or individual standing on or immediately next to barrier and have safety person control site.

   a. PART I: Activate emergency close, from open position - barrier should snap closed (1.5 sec); record time. Secondary controller should now be inoperative and will have to be reset from primary controller in Post 1.

b. PART II: Now park a vehicle over safety loop but BE SURE NO PART OF VEHICLE IS UNDER BARRIER. Then follow Part I sequence - Emergency close function should now override safety loop, and sequence should be the same as for Part I.

6. Cut all power to hydraulic pump and test that barrier can be operated required number of cycles using the back-up system. Record number of cycles.
7. Test that barrier will work under generator power.
8. Cut all power to hydraulic pump or electrical supply and test that barrier can be operated full cycle of unit under manual function.

C. Instructions for testing crash-rated drop arm system from Primary Control Panel

1. Check functions 3 thru 7 above from the primary.
2. Check reset function from primary.

3.4 CLEANING AND FINISHING

A. Clean exposed surfaces of crash-rated drop arm system, including primed surfaces and finished surfaces, exercising care to avoid damage to finishes; touch up minor blemishes in finished surfaces.

B. Refer to Division 09 Sections on painting and coatings for application of field-applied finish coatings over shop-applied primer coatings; not work of this section.

3.5 MANUFACTURER'S SERVICE

A. Services of a manufacturer's representative who is experienced in installation, adjustment, and operation of equipment supplied shall be available. The representative shall supervise installation, adjustment, and testing of the equipment.

3.6 TRAINING

A. Operator Training: Manufacturers' representative shall provide initial Operator training to Local Guard Force (LGF) personnel. Training shall be delivered at post of installation within one business day following commissioning of new system. Initial Operator training shall include:

1. Overview of system.
2. Essential controls and displays.
3. Safety precautions.

B. Supervisor Training: Manufacturer's representative shall provide initial Supervisor training for Regional Security Officer (RSO) or designated representative, LGF supervisor, and others as identified by RSO. This training shall be delivered at post of installation within one business day following commissioning of the new system. Initial Supervisor training shall include:

1. Overview of system.
2. Understanding of system's purpose and capabilities.
3. Essential controls and displays.
4. Safety precautions.

C. Maintenance Training: Manufacturer or representative shall provide Maintenance training, including MANUFACTURER'S CERTIFICATION TRAINING to level of "Factory Authorized Technician" status at manufacturer's facility for the following personnel:

1. Two instructional personnel from DS/SECD/TTB.
2. One instructional designer from DS/TPS/ISM.
3. One DS/C/ST subject matter expert (SME).
4. One person from OBO/CFSM/SM/SCD/TSB.

D. Manufacturer shall provide no less than two additional spaces per each Maintenance training class and/or training at their manufacturing facility for other DOS-designated personnel. This training must encompass all aspects of operations, maintenance, safety and repair.

E. Maintenance training shall enable personnel listed in this section to perform routine maintenance and inspection requirements, in compliance with the manufacturers' requirements.

F. Manufacturer shall make available annual refresher or re-certification Maintenance training for personnel identified in paragraph above on "Maintenance Training."

G. System upgrades that require more than four hours for operator accommodation shall require operator and supervisor training as specified in this specification as for new system.

END OF SECTION 324009

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 328400 Irrigation.

1.2 SUMMARY

A. Section Include:

1. Plants – trees, shrubs, groundcovers, ornamental grass, “tropicals,” xeriscaping, and desert plants (succulents and cacti), turf (lawn).
2. Tree stabilization.
3. Landscape edging.
4. Mulch.
5. Pesticide/Herbicide.
6. Maintenance.

1.3 DEFINITIONS, REFERENCES, AND APPLICABLE STANDARDS

A. General Definitions

1. Backfill: The earth used to replace or the act of replacing earth in an excavation.
2. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
3. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
4. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
5. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

6. Crown: The point where the stem or trunk of a plant meets the root system of any plants including turf.
7. Crownshaft (or Heart): The leaf bases of some pinnate leave palms (most notable being Roystonea regia but also including the genera Areca, Wodyetia, and Pinanga) form a sheath at the top of the trunk surrounding the bud where all the subsequent leaves are formed. The crownshaft takes the form of a column above the main trunk and beneath the main crown of leaves (frond).
8. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag but not protruding out from the sides. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
9. Finish Grade: Elevation of finished surface of planting soil, existing soil, or pavement, but not top of mulch.
10. Pesticide/Herbicide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
11. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
12. Planting Area: Areas to be planted.
13. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps organic matter and/or fertilizers to produce a soil mixture best for plant growth. See Article PLANTING SOIL for requirements of planting soils.
14. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, palms, shrubs, vines, ground covers, “tropicals,” ornamental grasses, succulents and cacti, bulbs, corms, tubers, turfs, or herbaceous vegetation.
15. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
16. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
17. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed, or simply “below finish grade.”

B. Measurements:
1. Caliper: Measurement of width.
2. O.C: Measurement of distance, defined as On Center spacing.
3. SM (square meters): Measurement of area.
4. CM: Measurement of volume expressed as Cubic Meter.

C. References:
1. American National Standards Institute (ANSI).
2. American Society for Testing Materials (ASTM).
3. International Society of Arboriculture (ISA).
4. United States Department of Agriculture (USDA).

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf, protect turf areas, and promptly repair damage caused by planting and other construction operations.

B. Coordination with Irrigation System: All plants shall be installed after the irrigation system for that planting area (or irrigation zone) is installed and tested for full function. See PART 3 EXECUTION below for plant installation steps. Also refer to Section 328400 Irrigation. Repair damage on irrigation system caused by planting and other construction operations immediately.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site with Project Director/COR and/or OBO Landscape Architect to discuss and inspect:
1. Planting area preparation
2. Irrigation system installation
3. Plants quality and availability at nursery
4. Soil and mulch
5. Planting schedule

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 same species are required, include a minimum of 6 photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
3. Soil Test: Include soil test results and amendment recommendations for each type of soil, existing on site as well as imported planting soil and topsoil, required to achieve planting design intent as indicated in Article PLANTING SOIL.

B. Samples for Verification: For each of the following:

1. Trees: At minimum, two photographs of each tree, from two different sides showing the full canopy spread and complete trunk and rootball (when roots not in ground) stocked at proposed nursery for inspection by OBO Project Director/COR and/or OBO Landscape Architect. Trees shall be pre-tagged and numbered. Tag numbers shall be identified in submittal. Maintain approved tagged trees with tags at the nursery until installation. The nursery itself is subject to inspection and approval by OBO.

2. Shrubs, Grasses, & Perennials: Samples of each variety and size stocked at proposed nursery for inspection by OBO Project Director/COR and/or OBO Landscape Architect. Maintain approved Samples at the nursery until installation as a standard for comparison. Mark them clearly with a sign “Approved Sample” and do not remove the signs until final acceptance of planting work on site. The nursery itself is subject to inspection and approval by OBO.
3. Organic Mulch: 1 L (1 quart) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the material to be furnished; provide an accurate representation of color, texture, and organic makeup.
4. Mineral Mulch: 2.5 kg (5 lb) of each mineral mulch required, in sealed strong plastic bags labeled with source of mulch. Samples shall be typical of the material to be delivered and installed on-site; provide an accurate indication of color, texture, sizes, and makeup of the material.
5. Weed Control Barrier: 300 by 300 mm (12 by 12 inches).
6. Slow-Release, Tree-Watering Device: One unit of each size required.
7. Edging Materials and Accessories: Manufacturer's standard size, to verify material and color selected.
8. Root Barrier: Width of panel by 300 mm (12 inches).

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include a list of similar projects completed by Installer with photographs demonstrating Installer's capabilities and experience. Include qualification of foreman, project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product including but not limited to plants, soil amendment, organic matter, fertilizer, mulch, and edging, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
3. Certify in writing that selected plants will be available at time of installation in size, quantity, and species specified in contract documents.

C. Pesticides and Herbicides: Certificate that products meet specified requirements. Product label and manufacturer's application instructions specific to Project. Qualification and license of pesticide/herbicide applicator.

D. Warranty: For special warranty.

E. Time Restrictions and Planting Conditions: After selection of plants, submit schedule indicating anticipated planting dates that reflects appropriate timing for plant varieties in Project locale. Include schedule for planting area preparation, irrigation system installation and testing.

1.8 CLOSEOUT SUBMITTALS

A. Inspection Report: Submit report with photographs on the completion of planting work, a report on condition of planting, irrigation system, and planting beds, including recommendations and remedial actions to be taken prior to Substantial Completion and during the warranty period.

B. Maintenance Record Calendar: Submit record calendar for use by Post maintenance of planting and lawns showing recommended tasks and schedule. Provide data entry space for five years of maintenance.

C. Maintenance Manual: Submit maintenance guidelines for planting and lawn. Provide instructions for plant placement, pruning, watering, mowing, fertilization, weeding, disease and pest control, and plant replacement. Coordinate with Irrigation Operation and Maintenance Manual. See Section 328400 Irrigation for Irrigation Operation and Maintenance Manual and Irrigation Schedule submittals.

1. Include product data sheets in manual, along with maintenance instructions and parts lists for those products.
2. Include planting soil quality requirements for future planting needs.
3. Include information on manufacturers and local sources of all products such as replacement plants, plating soil, amendments, fertilizers, and pesticides.
4. Include maintenance record calendar and schedule of tasks.

D. Integrated Pest Management Plan (IPM): Submit IPM for specified plants including schedule of recommended pest control.

1.9 QUALITY ASSURANCE

A. Certificates of Inspection required by law for transportation shall accompany the invoice for each shipment of seeds or plants. Inspection by OBO at the place of growth or nursery does not preclude rejection of materials at the project site.

B. Installer Qualifications:

1. Professional Membership: Installer shall be a certified member in good standing of local professional association in related field for installing plants.
2. Experience: Minimum of five years' experience in landscape installation required.
3. Foreman: All work shall be under direction and general supervision of Foreman who possesses verifiable experience and technical competence in plant propagation and installation. Foreman shall be present at all times while work is performed. Foreman is responsible for controlling quality of work and inspecting completed work to ensure that

the contract requirements are met. Foreman shall be the primary contact for the work of this Section.

4. Workers: All workers, through related training and on-the-job experience, shall be familiar with technical and safety aspects of planting and equipment used in such operations.
5. Pesticide Applicator: Locally licensed as required, and familiar with EPA standards.

C. All plants are subject to inspection and approval by Project Director/COR and/or OBO Landscape Architect and/or Post Facility Manager at place(s) of growth, nurseries, and upon delivery to site for conformance to project requirements for genus, species, variety, cultivar, size, shape, and quality. Project Director/COR and/or OBO Landscape Architect and/or Post Facility Manager may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work and during warranty period. Such approval does not limit the right of inspection and rejection during progress of work and warranty period. Submit written request for inspection of plant material at place of growth to Project Director/COR at least three weeks in advance of expected shipment date(s). Written requests shall state the place of growth and quantity to be inspected. Project Director/COR reserves the right to refuse inspection at that time if, in her/his judgment, sufficient quantity of plants is not available for inspection, or for any other reason. Replace rejected plants with new approved plants as soon as possible.

D. Plant Certification: Provide sod, seed, or original plant material that is certified by local certification agency, where such an agency is available. Certify that lawn material conforms to requirements identified for seeding, sodding, or sprigging.

E. Measurements: Measure according to ANSI Z60.1.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 150 mm (6 inches) above the root flare for trees up to 100-mm (4-inch) caliper size, and 300 mm (12 inches) above the root flare for larger sizes.
2. Palms: Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock to the bottom of crownshaft, or the lowest frond if the plant does not have crownshaft.
3. Other Plants: Measure with stems, petioles, and foliage in their normal position.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Staging: Store and maintain propagated or procured plant materials until site is in acceptable condition for plant material installation to begin. It is the responsibility of the Contractor to procure plants well in advance, care for, and grow to make sure they meet the required sizes, quality, and quantity when they are delivered to the site for installation.

B. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and U.S. and local laws if applicable.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, in or near existing tree protection areas, or on turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent areas and properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.
4. Coordinate schedule and location of bulk materials delivery with Project Director/COR at least seven days in advance.

D. Plants Preparation for Shipment: Protect and maintain plants until and during shipment to site for installation. Do not prune trees and shrubs before delivery. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, roots, and foliage to protect bark, branches, and roots from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape.

E. Shipping: Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered temperature-controlled vehicles, and keep plants cool and protected from sun, freeze, and wind at all times. Shipment shall occur in stages to prevent storage of plant material on site for more than 6 hours. Do not stack up many trees or containers of plants on top of each other to minimize the number of shipments. Place them neatly on shelves on trucks to deliver plants so that they are not damaged during delivery.

F. Storage: Store bulbs, corms, and tubers in a dry place at 16 to 18 deg C (60 to 65 deg F) until planting.

G. Protection: Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

H. Handling: Do not drop plants. Do not pick up plants by stems for trunks. Handle trees and shrubs by root ball.

I. Seed: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with local requirements, as applicable.

J. Sod: Do not dig sod at the nursery or other approved source until ready to transport sod to Project site or approved storage location. Do not cut turf roots below crowns. Deliver sod with minimum of 15 mm (1/2 inch) of soil attached. Protect sod from breakage and drying.

K. Time Restrictions and Planting Conditions: Planting dates shall be appropriate for locale and plant variety, recognizing temperature, precipitation, and other conditions.

L. Delivery: Deliver plants after the irrigation system is in place, tested, and running, and preparations of planting bed have been completed. Install plants immediately after delivery to the site. If planting is delayed more than six hours after delivery, set plants and trees in their

appropriate aspect (sun, filtered sun, or shade), out of the way of other construction and facility operations, protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before the time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist but not overly wet condition.

1.11 ACCEPTANCE

A. Plants will not be accepted until inspected on arrival to site and prior to planting/installation and approved by Project Director/COR. Plants not meeting specifications for quality and size at the time of delivery are subject to rejection. All rejected stock shall be replaced with stock of designated variety, size, age, and other applicable attributes as identified in Construction Documents at no additional cost to Government.

B. Plants shall comply with the following minimum conditions in order to be accepted by Project Director/COR:

1. General Condition: Healthy, free of pests and disease, and in flourishing condition with full canopy and foliage. Trees with excessively pruned or imbalanced canopy, thin foliage, or missing leader or major branches will be rejected.
2. Branches: Free of dead, broken, and dying branches and branch tips.
3. Foliage: Plants shall bear foliage of normal density, size, and color.
4. Root Ball: Free of weeds, debris, and pests. Plants with unproportionate small root balls will be rejected.
5. Characteristics: Meet all requirements as noted in landscape report and plant legend.

C. Sod shall comply with the following minimum conditions to be accepted by Project Director/COR:

1. Refer to product requirements.
2. Absence of visible joints.
3. All areas shall show a uniform stand of specified grass in healthy condition.

1.12 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of planting and construction contiguous with new planting by field measurements before proceeding with planting work.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply

products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

C. Seasonal Limitations: Proceed with planting of each plant specified only during seasons appropriate for its installation. Refer to plant schedule in IFC (Issued for Construction) drawing set which includes installation calendar.

1.13 WARRANTY

A. Warranty: Installer agrees to provide maintenance of entire planting, repair or replace damaged plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Death, decline, and unsatisfactory growth, except for defects resulting from abuse by the Government.
   b. Structural failures including plantings falling, leaning, or blowing over.
   c. Faulty performance of tree stabilization, edgings, tree grates, and other accessories.
   d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Two calendar years from the date of Substantial Completion.

3. Include the following remedial actions as a minimum:

   a. At end of warranty period, replace dead plants and plants not in vigorous, thriving condition, as determined by Project Director/COR or OBO Landscape Architect, or Post Facility Manager, without cost to the Government. Replacement shall occur as soon as weather conditions permit, and within the appropriate seasonal planting period.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at the end of the warranty period.
   c. Replacements shall closely match adjacent specimens of the same species. Replacements are subject to all requirements of this Section.
   d. Make necessary repairs due to plant replacements at no cost to Government.
   e. Warranty of replacement plants shall extend for an additional one-year period from the date of their acceptance by the Government after replacement. In the event that replacement plants are not acceptable during or at end of extended guarantee period, the Government may elect one more replacement or credit for each item.

1.14 MAINTENANCE SERVICE

A. Initial Maintenance Period: Begin immediately after each plant is planted and continue until end of warranty/guarantee period.

1. Maintenance consists of keeping plants in healthy growing condition, and keeping beds and individual pits in neat appearance, and shall be performed by qualified and approved

individuals. Plants shall be protected from damage. Maintenance activities include, but are not limited to, the following:

a. Watering: As necessary to promote natural growth. Apply in amounts to prevent
b. excessive runoff. Water shall be suitable for irrigation, and free from ingredients
c. harmful to plant life.
d. Weeding and Cleaning: Keep planting areas free of weeds, grass, and trash.
e. Cultivating.
f. Pruning.
g. Fertilizing.
h. Re-mulching.
i. Tightening and repairing of guys: Remove stakes and guy wires at end of warranty
j. period.
k. Straightening of trees to a plumb position.
l. Removal of dead material.
m. Resetting plants to proper grades or upright position.
n. Restore planting saucers.
o. Protection from insects, pests, and disease.

2. Irrigate, fertilize, and mow new turf for entire warranty period. Provide supplementary irrigation during the new plant establishment period.
3. During maintenance period, any decline in condition of plantings requires Contractor to take immediate action to identify potential problems and to undertake corrective measures. If Contractor does not have sufficient expertise or if problems persist, engage professional arborists and/or horticulturalists at no cost to Government to inspect plant materials and to identify problems and recommend corrective procedures. Advise OBO Representative immediately of such actions.

B. Continuing Maintenance Proposal:
1. Furnish proposal from Installer to Government for continuing maintenance agreement for period of one year starting from end of Initial Maintenance Period. State services, obligations, conditions, and terms of agreement period.
2. Upon execution of the agreement with Government, commence maintenance service on date when initial maintenance services are concluded.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule, indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of weeds, disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, cut off, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark");

crossing trunks; cut-off limbs more than 19 mm (3/4 inch) in diameter; or with stem girdling roots are unacceptable.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Plant Schedule: Provide plants of sizes, grades, and ball or container sizes complying with plant schedule and ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to OBO Landscape Architect and COR, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Standards: All plant materials, including nomenclature, shall conform with the following, except where specifically indicated otherwise in the Contract Documents:

1. American Standard for Nursery Stock, ANSI Z60.1: American Nursery and Landscape Association.
2. Hortus III: J.H. Bailey, Cornell University.

E. Growing Practice: Plants shall be grown in accordance with climatic conditions similar to those of the project site for at least two years, unless specifically noted otherwise. Each plant shall be exceptionally heavy for its species and variety, and so trained or favored in development and appearance as to be superior in form, number of branches, and compactness. Size and grade of plant materials shall conform to ANSI Z60.1 unless otherwise specifically indicated in the Contract Documents.

F. Labeling: In each shipment, label at least 25 percent of each herbaceous plant species and variety, each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

G. Arrangements; If formal arrangements or consecutive orders of plants are indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

H. Tree Size: Per plant schedule is contract requirement. Minimum sizes are noted below.

1. Shade Trees: Minimum size at installation shall be 75 mm (3 inches) caliper and 4 meters tall at time of planting.
2. Ornamental Flowering Trees: Minimum size at installation shall be 75 mm (3 inches) caliper and 2 meters tall at time of planting.
3. Palm Trees: Minimum size at installation shall be 3.5 meters tall to base of crownshaft at time of planting.
4. Multi-stem Palm Trees and Dwarf Palms: Minimum size at installation shall be 2.0 meters (6 ft and 6-3/4 inches) tall to base of crownshaft at time of planting.

I. Turfgrass Seed: Fresh, clean, dry, new-crop seed of suitable genetic identity, purity, and overall high quality to produce lawn free from noxious weeds as well as excessive quantities of other crops and weedy plants at time of harvest.

J. Turfgrass Sod: Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted. Use species with characteristics similar to those required for seed planting. Minimum 15 mm (1/2 inches) of soil attached at delivery.

K. Turfgrass Sprigs: Grower shall use only seed, cuttings, or other vegetative materials that have been harvested from a commercial operation. Provide sprigs from sod grown from certified, high-quality seed of know origin, or from plantings of certified grass seedlings or stolons.

L. Shrubs: Per Plant Schedule

M. Perennials: Per Plant Schedule

N. Grass and/or Forbe Seed Mix: Per Plant Schedule and:

1. Fresh, clean, dry, new-crop seed of suitable genetic identity, purity, and overall high quality to produce desired landscape design intent. Free from noxious weeds as well as excessive quantities of other crops and weedy plants at time of harvest.

2.2 PLANTING SOIL

A. General

Planting soil mix shall be naturally dark in color which indicates the existence of nutrients, adequate moisture, and organic matter in general. Leached white or off-white soil will be rejected. It shall contain no foreign matters like concrete, bricks, rocks, seeds, weeds, pests, or any debris of any size. It shall be well scarified and tilled when installed on site to create a soft permeable condition prior to planting. Compacted planting beds will be rejected.

B. Organic Matter

1. Sphagnum Moss.
2. Leaf Mold: Thoroughly shredded, composted leaf material.
3. Local Product: As approved by Project Director/COR.

C. Chemical Amendments

1. Dolomite Lime: Agricultural grade mineral soil conditioner containing **[35]** percent minimum magnesium carbonate and **[49]** percent calcium carbonate, 100 percent passing #65 sieve.
2. Iron Sulfate (Ferric or Ferrous): [**30-35**] percent iron, [**35-50**] percent sulphur. Shall be supplied by commercial fertilizer supplier.
3. Sulphate of Potash: Agricultural grade containing [**50 percent to 53 percent**] of water soluble potash.
4. Single Superphosphate: Commercial product containing [**18-20**] percent available phosphoric acid.
5. Calcium Nitrate: Agricultural grade containing [**15-1/2**] percent nitrogen.
6. Urea Formaldehyde: Commercial product containing [**38**] percent nitrogen.

7. Mineral Amendments:
   a. Grading Dry Weight Basis:

Percent Passing	Sieve Designation
100	10 mm (3/8 inch)
95-100	2.00 mm (#10)
20-80	0.41 mm (#40)
0-5	0.075 mm (#200)

8. Chemical Properties:
   a. Salinity: Saturation extract conductivity shall not exceed 3.0 milimhos/cm.
   b. Boron: Concentration in saturation extract shall not exceed 1.0 parts per million.
   c. Sodium Absorption Ratio (SAR), as calculated from analysis of saturation extract, shall not exceed 6.0.

D. Soil Mixes

1. General:

   a. Nutrient analysis and amendment: Unless specific amounts of chemical amendments are given in specification, the mix shall be tested for levels of pH, iron magnesium, potassium, phosphorous, salts, carbon, and nitrogen, and shall be adjusted to required fertility levels. The following are acceptable results for all soil types.

pH Range	5.0-7.0
Magnesium-Mg	100+ units
Phosphorous-P205	150+ units
Potassium-K20	120+ units
Carbon Nitrogen Ration-C/N	Max 30:1
Soluble Salts/Conductivity	Not to exceed 500 ppm/0.5 mmhos/cm (organics less than 5 percent), not to exceed 3000 ppm/2.5 mmhos/cm (organics greater than 5 percent)

2. Soil fractions shall be those defined by local Soil Conservation Service or similar entity. Soil fractions are by weight of mineral fraction without organics.
3. Organic content shall be tested by combustion test.
4. Unit weights shall be measured as wet density at 100 percent compaction and optimum moisture; reference ASTM D698.
5. Thoroughly combine all ingredients to create homogeneous mixtures prior to placement on subgrade.

E. Lawn Mix

1. Onsite or imported material naturally occurring or amended to meet the following:
   a. Loam, sandy loam, or clayey loam, reasonably free of subsoil, clay lumps, stones, or gravel of any dimensions, and debris. Free of excessive weeds, roots, and root mats, and any substance detrimental to plant growth. Imported topsoil shall be from an identifiable source.

b. Composition of mineral fraction:
   1) Sand: 20-60 percent.
   2) Silt: 12-50 percent.
   3) Clay: 7-40 percent.
c. Organic content: 3-5 percent.
d. General requirements as defined for general soil mixes.

F. Shrub and Tree Mix

1. Mix Ratio: Approximately 3:1 by volume mixture of loam or sandy loam and organic amendment meeting the following requirements:
   a. Composition of mineral fraction:
      1) Sand: 23-73 percent.
      2) Silt: 16-50 percent.
      3) Clay: 7-27 percent.
   b. Organic content: 4-8 percent.

G. Extensive Green Roof Soil Mix – per extensive green roof soil manufacturer specifications.

H. Intensive Green Roof Soil Mix – per intensive green roof soil manufacturer specifications.

2.3 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.4 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Locally available:
   a. ground or shredded bark
   b. bark chips
   c. pine straw or needles
   d. peanut, pecan, or cocoa bean shells
   e. Seed husks
   f. Shredded palm tree fronds.
   g. Or other organic mulch alternative to be approved by OBO Landscape Architect.

2. Organic Mulch shall be naturally dark brown in color indicating that it is already in composting process. Mulch that has negative effects on planting soil quality such as light color fresh organic mulch and artificially painted mulch are not permitted.
3. Size Range: 76 mm (3 inches) maximum, 10 mm (0.25 inch) minimum.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 - 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 25-mm (1-inch) sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. **[Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste are not permitted.]**

3. **[Stone/Mineral Mulch for planting areas: XX]**

2.5 WEED-CONTROL BARRIERS

A. [Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 101g/sq. m (3 oz./sq. yd.) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.]

B. [Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 162 g/sq. m (4.8 oz./sq. yd).]

2.6 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.7 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new [**hardwood**] [**softwood with specified wood pressure-preservative treatment**], free of knots, holes, cross grain, and other defects, 38-by-38-mm actual (2-by-2-inch nominal) by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring 200 mm (8 inches) in diameter and 1200 mm (48 inches) long, treated with specified wood pressure-preservative treatment.

3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or [**turnbuckles**] [**compression springs**].
4. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, 2.7 mm (0.106 inch) in diameter.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cables: Five-strand, 4.8-mm- (3/16-inch-) diameter, galvanized-steel cable, with zinc-coated [**turnbuckles**] [**compression springs**], a minimum of 75 mm (3 inches) long, with two 10-mm (3/8-inch) galvanized eyebolts.
7. Flags: Standard surveyor's plastic flagging tape, white, 150 mm (6 inches) long.

B. Palm Bracing: Battens or blocks, struts, straps, and protective padding.

1. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 38-by-89-mm actual (2-by-4-inch nominal) by lengths indicated.
2. Straps: Adjustable steel or plastic package banding.
3. Padding: Burlap.

2.8 LANDSCAPE EDGINGS

A. Lawn Edging: Provide steel edging, except provide precast concrete where corrosion is a risk.

1. Steel: 100 mm (4 inches) deep x 6 mm (1/4 inch) thick steel with stakes to hold edging in place.
2. Concrete: 150 mm (6 inches) wide by 150-200 mm (6-8 inches) deep precast curb.

B. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Edging Size: 6.4 mm (1/4 inch) thick by 125 mm (5 inches) deep.
2. Stakes: Tapered steel, a minimum of 300 mm (12 inches) long.
3. Accessories: Standard tapered ends, corners, and splicers.
4. Finish: Manufacturer's standard finish.

2.9 TREE GRATES

A. Tree Grates: Manufacturer's standard tree grates and frames.

1. Grates: ASTM A48/A48M, Class 250 (Class 35) or better, gray-iron castings.
2. Frames: ASTM A48/A48M, Class 250 (Class 35) or better, gray-iron castings of shape, pattern, and size indicated.

B. Shape and Size: As indicated on Drawings.

C. Finish as indicated on drawings.

1. Color: as indicated on drawings.

2.10 TREE-WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for on grade irrigation of plants and emptying its water contents over **[two to nine hours]**; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

1. Color: Manufacturer standard color and COR approved.

2.11 MISCELLANEOUS PRODUCTS

A. Root Barrier: Black, molded, modular panels 610 mm (24 inches) high (deep), 2.2 mm (85 mils) thick, and with vertical root deflecting ribs protruding 19 mm (3/4 inch) out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

C. Burlap: Non-synthetic, biodegradable.

D. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D448 for Size No. 8.

E. Planter Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

F. Jute mesh: as manufactured for erosion control.

G. Straw mats: as manufactured for temporary erosion control.

H. Geogrid: as manufactured for slope stabilization and erosion control.

PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

A. Complete the following steps for planting area establishment before installing the irrigation system in the planting area. See Section 328400 Irrigation for irrigation system installation.

B. Within the entire area to be landscaped, the Contractor shall complete the following site topsoil preparation items to eradicate existing weeds and natural groundcover. Initiate site topsoil preparation as stated herein, and coordinate work with irrigation system and utility lines.

C. Prepare areas to be landscaped by clearing weeds and groundcover, stumps, stones larger than 25 mm (1 inch) in diameter, roots, and debris or materials that may hinder proper grading, tillage,

planting, or subsequent maintenance operations by approved means. Cleared material shall be totally removed from the Project site and properly disposed of the property.

3.2 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance without damaging completed work.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Verify subgrade to ensure that rough grading is correct, and that suitable subgrade materials exist before starting plant installation.
5. Verify service and utility location and irrigation components.
6. Verify that topsoil and subgrade are damp when topsoil is spread. Uniformly moisten excessively dry soil that is not workable and/or too dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Project Director/COR, and replace with new planting soil.

C. Test Drainage: Test five plant beds and pits chosen by Project Director/COR by filling with water twice in succession. Note the time at which water is put into pit or bed for second filling. Notify Project Director/COR of the time it takes for pit or bed to drain completely. Do not proceed with planting operations until Project Director/COR has reviewed test drainage results and accepted soil drainage conditions.

D. Wrap shade trees with burlap fabric over trunks to first main branch to protect from wind and other damage during digging, handling, and transportation.

E. Make sure all irrigation systems are in place, completed, tested, and running before starting plant installation. Verify all locations of subgrade irrigation system installed are clearly marked with flags or other markers to avoid damaging completed irrigation installation. See Section 328400 Irrigation.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Protect structures, utilities, irrigation system, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Check and make sure all subgrade irrigation system and pipe are installed and clearly flagged/marked.

D. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Project Director's/COR's acceptance of layout before excavating or planting. Make minor adjustments as required.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling with root flare 50 mm (2 inches) above adjacent finish grades. Scarify sides of planting pit smeared or smoothed during excavation unless it is on the root barrier side.
2. Excavate approximately three times as wide as root ball diameter for stock.
3. Excavate at least 300 mm (12 inches) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Subgrade of planting areas shall be loosened or scarified to a minimum of 75 mm (3 in.) depth prior to spreading planting soil. Subgrade shall be brought to true and uniform grade and shall be cleared of stone greater than 50 mm (2 in.), sticks, and other deleterious and extraneous materials.
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
10. Before planting, obtain Project Director's/COR's acceptance of finish grade; restore planting areas if eroded or otherwise disturbed after finish grading.
11. Keep excavations covered or otherwise protected after working hours and when unattended by Installer's personnel.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil or mixed into planting soil if its property meets above planting soil qualification and approved by OBO Landscape Architect in writing. Remove all debris and poor-quality parts of excavated soil before using for backfill.

C. Obstructions: Notify Project Director/COR if unexpected rock, obstructions, or hardpan layer detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Project Director/COR if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 50 mm (2 inches) above adjacent finish grades.

1. Backfill: See Article PLANTING SOIL.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill pits with planting soil. Work soil carefully into voids and pockets, tamping lightly every 150 mm (6 in.). Finish backfilling and tamping, and form saucer around plant pits as indicated on Construction Drawings. When planting pit is approximately one-half filled, water thoroughly before placing the remainder of backfill. Repeat watering until no more water is absorbed. Fill saucer with water and leave water to soak in the soil. Then fill saucer with water again. Repeat this until the roots of the plants are well established.

D. Balled and Potted, and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 50 mm (2 inches) above adjacent finish grades.

1. Backfill: See Article PLANTING SOIL.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill pits with planting soil. Work soil carefully into voids and pockets, tamping lightly every 150 mm (6 in.). Finish backfilling and tamping, and form saucer around plant pits as indicated on Construction Drawings. When planting pit is approximately one-half filled, water thoroughly before placing the remainder of backfill. Repeat watering until no more water is absorbed. Fill saucer with water and leave water to soak in the soil. Then fill saucer with water again. Repeat this until the roots of the plants are well established.

E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 50 mm (2 inches) above adjacent finish grades.

1. Backfill: See Article PLANTING SOIL.
2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill pits with planting soil. Work soil carefully into voids and pockets, tamping lightly every 150 mm (6 in.). Finish backfilling and tamping, and form saucer around plant pits as indicated on Construction Drawings. When planting pit is approximately one-half filled, water thoroughly before placing the remainder of backfill. Repeat watering until no more water is absorbed. Fill saucer with water and leave water to soak in the soil. Then fill saucer with water again. Repeat this until the roots of the plants are well established.

F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 25 mm (1 inch) above adjacent finish grade.

1. Backfill: Soil mix per plant legend.
2. Spread roots without tangling or turning toward surface. Plumb before backfilling and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside soil-covered roots about 25 mm (1 inch) from root tips; do not place tablets in bottom of the hole or touching the roots.

   a. Quantity: Two per plant.

G. Watering Pipe Watering System: See irrigation specifications.

H. Slopes: When planting on slopes, set the plant so the root flare on the uphill side flushes with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil but no more than 50 mm (2 inches). Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.

C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Where possible, orient the tree in the same direction as in its original location.

3.7 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural/arboricultural practices and as directed by OBO Landscape Architect. Unless otherwise indicated by Project Director/COR or OBO Landscape Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character. Do prune or cut trees for transportation to project site.

C. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

A. Retain this article if tree stabilization is required; coordinate with details on Drawings. See Evaluations for discussion of advantages and disadvantages of stabilization methods.

B. Protect trunks of trees and palms. Do not nail any stabilization materials and equipment onto trunks. Wrap trunks with soft materials like rubber sheets to protect when attaching or tying wires, stakes, or any other support materials.

C. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:

a. Stake trees of 25- through 125-mm (1- through 5-inch) caliper. Use a minimum of two stakes of length required to penetrate at least 450 mm (18 inches) below bottom of backfilled excavation and to extend at least 1830 mm (72 inches) above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

b. Stake trees with two stakes for trees up to 3.6 m (12 feet) high and 63 mm (2-1/2 inches) or less in caliper; three stakes for trees less than 4.2 m (14 feet) high and up to 100 mm (4 inches) in caliper. Space stakes equally around trees.

2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

D. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.

1. Site-Fabricated Palm-Bracing Method:

a. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.

b. Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.

3.9 INSTALLATION OF ROOT BARRIER

A. Install root barrier where trees are planted within 1200 mm (48 inches) of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.

B. Align root barrier with bottom edge angled at 20 degrees away from the paving or other hardscape element. Install root barrier linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.

C. Install root barrier continuously for a distance of 1500 mm (60 inches) in each direction from the tree trunk, for a total distance of 3 m (10 feet) per tree. If trees are spaced closer, use a single continuous piece of root barrier.

1. Position top of root barrier according to manufacturer's written recommendations.
2. Overlap root barrier a minimum of 300 mm (12 inches) at joints.
3. Do not distort or bend root barrier during construction activities.
4. Do not install root barrier surrounding the root ball of tree.

3.10 PLACING SOIL IN PLANTERS

A. Place a layer of drainage gravel at least 100 mm (4 inches) thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 150 mm (6 inches) up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.

B. Fill planter with planting soil. Place soil in lightly compacted layers to an elevation of 38 mm (1-1/2 inches) below top of planter, allowing natural settlement.

3.11 GROUND COVER, ORNAMENTAL GRESS, AND “TROPICALS” PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil per Article PLANTING SOIL for backfill.

C. Dig holes large enough to allow spreading of roots in planting bed prepared per Article PLANTING AREA ESTABLISHMENT of this specification.

D. Protect and do not damage irrigation lines and drip tubes.

E. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

F. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

G. Water thoroughly after planting, taking care not to cover plant crowns with wet soil. Repeat watering daily to keep the planting bed moist all day unless it is not recommended in local practices.

H. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.12 XERISCAPING AND DESERT PLANTING

A. Set out and space xeriscaping and desert plants as indicated on Drawings.

B. Dig holes large enough to allow spreading of roots in planting bed prepared per Article PLANTING AREA ESTABLISHMENT of this specification.

C. Protect and do not damage irrigation lines and drip tubes.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil. Repeat watering daily per recommended in local practices.

G. If provided, place and adjust point-source drip emitters per drawings. Ensure water from each emitter covers the root area of the plant completely.

H. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.13 PLANTING AREA MULCHING

A. Install weed-control barriers as required on plans before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 300mm (12 inches) and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees in Turf Areas: Apply organic mulch ring of 75-mm (3-inch) average thickness, with 900-mm (36-inch) radius around trunks or stems. Do not place mulch within 150 mm (6 inches) of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 50-mm (2-inch) average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades.
3. Mineral Mulch in Planting Areas: Where indicated in drawings, apply 50-mm (2-inch) average thickness of mineral mulch over whole surface of planting area, and finish level with adjacent finish grades.
4. Do not step on or damage subgrade irrigation lines and drip tubes and plants during this operation.

3.14 NO PLANTING STRIP

A. Do not plant directly against perimeter fence/wall. Place landscaping mulch 800mm (24 inches) wide and 75mm (3 inches) deep over weed control barrier over compacted base. Separate planting and mulch areas from lawn and other planting with edging.

3.15 INSTALLATION OF EDGING

A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 760 mm (30 inches) apart, driven below top elevation of edging.

3.16 INSTALLATION OF TREE GRATES

A. Tree Grates: Install according to manufacturer's written instructions. Set grate segments flush with adjoining surfaces. Shim from supporting substrate with soil-resistant plastic. Maintain a 75-mm- (3-inch-) minimum growth radius around base of tree; break away portions of casting, if necessary, according to manufacturer's written instructions.

3.17 INSTALLATION OF TEMPORARY SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree for root establishment.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

C. Remove them once the root is established or at the end of warranty period.

3.18 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or

vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

D. The Contractor is responsible for plant maintenance during construction, through plant establishment period, and until the end of warranty period.

3.19 PESTICIDE APPLICATION

A. Spray/apply insecticides, pesticides, and herbicides, to inhibit damage from insects, pests, and diseases, only with approval of Project Director/COR or Facility Manager (during warranty period). Spray products and application shall conform to the National Arborist Association Standards under the section titled “Standards for Pesticide Application Operations.” and as approved by Project Director/COR or Facility Manager. All insecticides, pesticides, and herbicides shall be EPA approved. Spraying shall be performed only by authorized and certified personnel.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.20 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged during construction operations, in a manner approved by Project Director/COR.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Project Director/COR or Facility Manager.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the warranty period.

1. Provide replacement new trees of same size as those being replaced.
2. Species of Replacement Trees: Same species being replaced or species selected by Project Director/COR or Facility Manager with suggestions from OBO Landscape Architect.

3.21 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean the site daily. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Project site.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.22 DEMONSTRATION & TRAINING

A. Comply with Division 01, Section 017905 “Demonstration and Training” for general requirements of demonstration and training documentation.

B. The landscape Installer’s skilled representative shall provide ‘hands-on’ training sessions for the Government O&M personnel.
   1. Schedule as follows:
      a. Classroom Instruction: Two (2) hours.
      b. Field Demonstration: Six (6) hours.

C. Training shall cover the following topics:
   1. The classroom session shall review maintenance manuals, maintenance record schedules, and any lessons learned during the initial service period for all plantings and ground cover. Additionally, include procedures and activities required per the maintenance service contract section with this specification in coordination with complete irrigation/wastewater treatment system. Relevant health and safety issues shall be addressed in coordination with the Integrated Pest Management Plan. Inspection requirements and/or techniques with appropriate specialty tools.
   2. Provide a field demonstration for O&M/Gardening personnel on the landscape maintenance requirements within two months of concluding contractor’s initial maintenance service period.

END OF SECTION 329300

SECTION 331117 - WATER SUPPLY WELLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. **[Cable-tool] [Rotary drilled] [Reverse-rotary drilled] [Driven]** water supply wells.

2. **[Line-shaft] [Submersible]** well pumps.

B. Related Section:

1. Section 223230 “Potable Water Treatment” for compound water treatment.
2. Various Division 22 sections for valves, fittings, and similar work.
3. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
4. Section 260525 "Grounding and Bonding for Electrical Systems."
5. Section 331414 “Fire Service Mains and Appurtenances.”
6. Section 331416 “Site Water Distribution Piping.”
7. Division 33 Section on site sanitary sewerage piping and structures.

1.2 PERFORMANCE REQUIREMENTS

A. Continuous Verified Yield of **<Insert Cubic Meters per Day (CMD)>**. Design complete well system with sufficient integration of well components, and of well with other systems, to ensure all components are matched and capable of delivering, conveying, and treating continuous yield.

B. Investigations and Analysis: Investigate and analysis geotechnical, geophysical, and ground water hydrology characteristics required to plan, locate, and construct complete well system which will provide required continuous yield.

1. General: EPA 570/9-75-001 and AWWA A100.
2. Development of Monitoring Well: ASTM D 5521.
3. Sieve Analysis: ASTM C 136.
4. Soil and Rock Sampling: ASTM D 1586, ASTM D 1587, and ASTM D 5079.
5. Soil and Rock Characteristics: ASTM D 2216, ASTM D 2487, ASTM D 2488, ASTM D 4318, and ASTM D 4750.
6. Water Analysis: AWWA EWW and EPA 600/4 – 79/020.
7. Contaminants: EPA 816-F-09-004 standards after passage through water treatment facility provided as part of this water supply well system.

C. General Well Standards:

1. Well Construction: EPA 570/9–75–001, and AWWA A100.
2. Examination and Treatment: AWWA B300, AWWA B301, AWWA C654, AWWA EWW, EPA 816-F-09-004.
3. EPA 600/4 – 79/020.

D. Protect wells against surface and subsurface contamination in accordance with EPA 570/9-75-001 and EPA 816-K-02-003.

E. Hazardous Materials: Where hazardous material is encountered, handle in accordance with 49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans."

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F. Well Location: Locate water supply wells at distances identified in Table 1.2, "Minimum Well Location Distances:"

TABLE 1.2

MINIMUM WELL LOCATION DISTANCES

STRUCTURE OR TOPOGRAPHIC FEATURE	MIN. DISTANCE (M)
Building Foundation – Non-Treated	3
Building Foundation with Termite Treatment	15
[1]Residential Sewer Line	15
Wastewater Treatment Plant or Sewage Lift Station	30
Individual Septic Tanks	15
Septic Tank Drainfields	30
Underground Fuel Storage Tanks	30
Cemetery	30
Non-Potable Water Well	30
Property Line	15
Storm Water Detention Basin or Infiltration Beds	15

[1] If sewer line is located within 15 meters of potable water supply well, sewer line must be continuous and have permanent sealed joints. If sewer line is closer than 3 meters to potable water supply well, encase sewer line in conductor pipe that is nominally two sizes larger than sewer line throughout 3 meter distance from well. Seal casing to ends of sewer line with vent that extends above ground, and at least 3 meters down gradient from well.

G. Potable well water which is pumped from aquifer less than 15 meters from ground surface must be considered as surface water for **[potential future]** treatment for supply of potable well water.

1.3 SUBMITTALS

A. Product Data: Submit certified performance curves and rated capacities of selected well pumps and furnished specialties and accessories for each type and size of well pump indicated.

B. Well Installation Plan: Describe the following:

1. Well drilling methods and installation procedures including any temporary casing used, placement of filter pack and seal materials, drill cuttings and fluids disposal and soil/rock sample disposition.
2. Well construction materials including well screen, riser pipe, centralizers, air line and gauge, tailpiece, filter pack and filter pack gradation, bentonite, drilling mud, drilling fluid additives, drilling water, cement, and well protective measures.
3. Mechanical and electrical equipment to be installed both inside well casing but also inside of well head vault, and to first point of connection to site wide water, instrumentation, and electrical power distribution, and transmitting systems. Include catalogue and name plate information.
4. Quality control procedures to be used for vertical alignment checks and controls, and for placement of filter pack and boring seals, including depth measurements.
5. Procedures for contamination prevention, and for decontamination of well materials and equipment.
6. Cover protection scheme for well head protective surface, including frost heave or freeze protection provisions.
7. Well development methods.
8. List applicable publications and standards
9. Well decommissioning/abandonment procedures.
10. Well capacity testing techniques.
11. Geophysical techniques to be employed at site.
12. Permanent pump, including testing and commissioning procedures.
13. Include investigations and analysis identified in Article on PERFORMANCE REQUIREMENTS.
14. Forms to be used for written boring logs, installation diagram of wells, geophysical logs, well development records, well sampling data records, required well registration records, and well abandonment records.

C. Shop Drawings: Show layout and connections for well pumps.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Show piping layouts and isometrics within the well head vault to the first point of connection at the contract limit line.
3. Setting Drawings: Include templates and directions for installing foundation bolts, anchor bolts, and other anchorages.

D. Qualification Data:

1. Well driller.
2. Testing Agency.

E. Field Documentation Report: Record the following data for each water supply well:

1. Casings: Material, diameter, thickness, weight per meter (foot) of length, and depth below grade.
2. Screen: Material, construction, diameter, and opening size.

3. Pumping Test: Static water level, maximum safe yield, and drawdown at maximum yield.
4. Log: Formation log indicating strata encountered.

F. Alignment Certification: Certify that well is aligned and plumb within specified tolerances.

G. Field quality-control reports, including the following:

1. [Pilot-hole and neighborhood well test data and analysis.]
2. Substrata formations.
3. Water-bearing formations.
4. Water levels.
5. Hydrostatic tests.
6. Laboratory water analysis.
7. Well-screen analysis.
8. Performance test data.

H. Operation and Maintenance Data: For each well pump, **[valves, motors, and well screen]** to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Well Driller Qualifications: An experienced water supply well driller licensed in the jurisdiction where Project is located that can provide documentary evidence of five years acceptable experience with ground water development projects of a similar nature.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Comply with the OBO-ICS NEC (NFPA 70, "National Electrical Code" as amended by OBO).

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE and marked for intended use.

D. Comply with standards referenced in section 1.2 of these specifications. If there is any conflict between any of the standards referenced the most rigorous requirement will be applied.

1.5 [PROJECT CONDITIONS

A. [Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Project Director/COR no fewer than seven days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Project Director/COR's written permission.]

B. [Well Drilling Water: Provide temporary water and piping for drilling purposes.]

PART 2 - PRODUCTS

2.1 WELL CASINGS

A. [Steel Casing: AWWA C200, single ply, steel pipe with threaded ends and threaded couplings for threaded joints.]

B. [Acrylonitrile-butadiene-styrene (ABS) Casing: ASTM F 480, ABS, Schedule [40] [80] bell-and-spigot pipe and couplings for solvent-cemented joints.]

C. [Polyvinyl Chlorine (PVC) Casing: ASTM F 480[and NSF 14,] PVC, Schedule [40] [80] bell-and-spigot pipe and couplings for solvent-cemented joints. [Include NSF listing mark "NSF wc."]]

D. [Pitless Adapter: Fitting, of shape required to fit onto casing, with waterproof seals.]

E. [Pitless Unit: Factory-assembled equipment that includes pitless adapter.]

F. Well Seals: Casing cap, with holes for piping and cables, that fits into top of casing and is removable, waterproof, and vermin proof.

2.2 GENERAL PIPING

A. Underground Distribution Piping to Battery Limit: AWWA C200 or C604.

B. Steel Piping: AWWA C200, AWWA C206, AWWA C604, ASTM A 139/A 139M, ASTM A 312/A 312M

C. PVC Piping: ASTM D 1785.

2.3 [GROUT

A. Cement: ASTM C 150, Type II.

B. Aggregates: ASTM C 33, fine and coarse grades.

C. Water: Potable.]

2.4 WATER WELL SCREENS

A. Screen Material: Fabricated of ASTM A 666, Type 304 stainless steel **[, welded; with continuous-slot, V-shaped openings that widen inwardly] [tube; with slotted or perforated surface and designed for well-screen applications]**. Approval of final selection is required by Project Director/COR.

1. Screen Couplings: Butt-type, stainless-steel coupling rings.
2. Screen Fittings: Screen, with necessary fittings, closes bottom and makes tight seal between top of screen and well casing.
3. Maximum Entering Velocity: 0.03 m/s (0.1 fps).

2.5 [PACK MATERIALS

A. [Coarse, uniformly graded filter sand, maximum 3 mm (1/8 inch) in diameter.]

B. [Fine gravel, maximum 6 mm (1/4 inch) in diameter.]

2.6 [LINE-SHAFT WELL PUMPS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Turbine Pump Co.
2. Crane Pumps and Systems; Deming Pumps.
3. Flowserve Corporation; Flowserve Pump Division.
4. ITT Industries; Goulds Pumps.
5. Johnston Pump Company.
6. Pentair Pump Group; Fairbanks Morse Pump.
7. Pentair Pump Group; Layne/Verti-Line.
8. Sterling Fluid Systems (USA) Inc.; Peerless Pump.
9. WDM Pumps Inc.
10. <Insert manufacturer's name.>

B. Description: Line-shaft, [water] [oil]-lubricated, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:

1. Impeller Material: [Stainless steel] [Carbon steel] [Bronze].
2. Motor: Full-voltage starting, vertical hollow- or solid-shaft, squirrel-cage induction type complying with ANSI C50.10.
3. Pump Base: Cast iron or fabricated steel.
4. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

C. Capacities and Characteristics:

1. **Capacity: <Insert L/s (gpm).>**
2. **Discharge Head: <Insert kPa (psig).>**
3. **Discharge Size: <Insert DN (NPS).>**
4. **Speed: <Insert rpm.>**
5. **Motor Horsepower: <Insert value.>**
6. **Lift: <Insert m (feet).>**
7. **Pressure Rating: <Insert kPa (psig).>**
8. **Volts: <Insert value.>**
9. **Phases: <Insert value.>**
10. **Hertz: <Insert value.>**
11. **Full-Load Amperes: <Insert value.>**
12. **Minimum Circuit Ampacity: <Insert value.>**
13. **Maximum Overcurrent Protection: <Insert amperage.>]**

2.7 SUBMERSIBLE WELL PUMPS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aermotor Pumps, Inc.
2. American Turbine Pump Co.
3. Crane Pumps and Systems; Deming Pumps.
4. Grundfos.
5. ITT Industries; Goulds Pumps.
6. Jacuzzi, Inc.; Jacuzzi Brothers.
7. Johnston Pump Company.
8. McDonald, A. Y. Mfg. Co.
9. Pentair Pump Group; Layne/Verti-Line.
10. Pentair Pump Group; Myers, F. E.
11. Reda Productions Services; Schlumberger Limited.
12. Sta-Rite Industries, Inc.; Water Systems Group.
13. Sterling Fluid Systems (USA) Inc.; Peerless Pump.
14. USFilter/EMU Products.
15. Weber Industries, Inc.
16. <**Insert manufacturer's name.**>

B. Description: Submersible, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:

1. Pumps: AWWA A102.
2. Impeller Material: [**Stainless steel**] [**Silicon bronze**].
3. Motor: Capable of continuous operation under water, with protected submersible power cable.
4. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

5. Discharge Piping: ASTM D 2239, SIDR Numbers 5.3, 7, or 9 polyethylene plastic (PE) pipe; made with PE compound number required to give pressure rating not less than [**1100 kPa (160 psig)**] [**1400 kPa (200 psig)**]. Include NSF listing mark "NSF pw."

   a. Insert Fittings for PE Pipe: ASTM D 2609, made of polyamide (nylon) plastic (PA), polypropylene plastic (PP), or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

C. Capacities and Characteristics:

1. Capacity: <**Insert L/s (gpm).**>
2. Discharge Head: <**Insert kPa (psig).**>
3. Discharge Size: <**Insert DN (NPS).**>
4. Speed: <**Insert rpm.**>
5. Motor Horsepower: <**Insert value.**>
6. Lift: <**Insert m (feet).**>
7. Pressure Rating: <**Insert kPa (psig).**>
8. Volts: <**Insert value.**>
9. Phases: <**Insert value.**>
10. Hertz: <**Insert value.**>
11. Full-Load Amperes: <**Insert value.**>
12. Minimum Circuit Ampacity: <**Insert value.**>
13. Maximum Overcurrent Protection: <**Insert amperage.**>

2.8 MOTORS

A. General requirements for motors are specified in **[Division 22 Section on common motor requirements for plumbing equipment]**.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. [Pilot-Hole Data: Drill pilot hole in location anticipated for well. Analyze data to identify suitable well design.]

B. [Neighborhood Well Data: Review operating and test analyses.]

3.2 INSTALLATION

A. Construct well using method identified in SUMMARY Article.

B. Take samples of substrata formation at 3 meter (10-foot) intervals and at changes in formation throughout entire depth of each water supply well. Carefully preserve samples on-site in glass jars properly labeled for identification.

C. Excavate for mud pit or provide aboveground structure, acceptable to Project Director/COR, to allow settlement of cuttings and circulation of drill fluids back to well without discharging to on-site waterways.

D. [Enlarge pilot hole and install permanent casing, screen, and grout. Install first section of casing with hardened steel driving shoe of an OD slightly larger than casing couplings if threaded couplings are used.]

E. Set casing and liners round, plumb, and true to line. **[Extend casings to minimum of 15 meters below ground surface or rock formation to prevent ground water level contamination.]**

F. Join casing pipe as follows:

1. Ream ends of pipe and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside casing before installation.

3. [Cut bevel in ends of casing pipe and make threaded joints.]

4. [Clean and make solvent-cemented joints.]

G. [Mix grout in proportions of 0.03 cu. m (1 cu. ft.) or a 42 kg (94-lb) sack of cement with 19 to 23 L (5 to 6 gal.) of water. Bentonite clay may be added in amounts of 1.4 to 2.3 kg/0.03 cu. m (3 to 5 lb/cu. ft.) for a 42 kg (94-lb) sack of cement. If bentonite clay is added, water may be increased to 25 L/0.03 cu. m (6.5 gal./cu. ft.) of cement.

H. Place grout continuously, from bottom to top surface, to ensure filling of annular space in one operation. Do not perform other operations in well within 72 hours after grouting of casing. When quick-setting cement is used, this period may be reduced to 24 hours.]

I. [Provide permanent casing with temporary well cap. Install with top of casing 900 mm (36 inches) above finished grade located at 5 meters from center of hole.]

J. After casing is set and concrete placed, complete drilling to estimated depth of usable groundwater. Once usable groundwater is located, testing agency must identify estimated safe yield for well prior to completing well. Develop wells to maximum yield per meter (foot) of drawdown.

1. Extract maximum practical quantity of sand, drill fluid, and other fine materials from water-bearing formation.
2. Avoid settlement and disturbance of strata above water-bearing formation.

3. Do not disturb sealing around well casings.
4. Continue developing wells until water contains no more than 2 ppm of sand by weight when pumped at maximum testing rate.

K. Install [**line-shaft**] [**submersible**] well pumps according to HI 2.1-2.4 and provide access for periodic maintenance.

1. Before lowering permanent pump into well, lower a dummy pump that is slightly longer and wider than permanent pump to determine that permanent pump can be installed. Correct alignment problems.
2. Before lowering permanent pump into well, start pump to verify correct rotation.
3. Securely tighten discharge piping joints.

4. [Locate line-shaft well pump near well bottom; locate motor above grade. Install driver plate to correctly align motor and pump.]

5. [Connect motor to submersible pump and locate near well bottom.

a. Connect power cable while connection points are dry and undamaged.
b. Do not damage power cable during installation; use cable clamps that do not have sharp edges.
c. Install water-sealed surface plate that will support pump and piping.]

L. Well Completion: After acceptance of field quality control testing by Projector/COR, perform well completion.

1. Surface Completion: Provide concrete surface protection extending at least one meter from well casing.
2. Top of well must extend above 100-year flood elevation.
3. Provide casing vent that extends above top of well casing, with pipe turned down and capped with mesh to prevent insect from entering well.
4. Seal space between well casing and concrete with silicone sealant.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 331416 "Site Water Distribution Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

1. Connect piping between well pump and water piping.

2. **[Connect water distribution system in trench to well pipe at pitless** [**adapter**] [**unit**]**.]**

3. [Connect building water distribution to well pipe inside well house.]

B. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

3.4 WELL ABANDONMENT

A. [Comply with EPA 570/9-75-001 and ASTM D 5299 when abandoning water supply wells. Fill and seal holes and casings and restore ground surface to finished grade.]

B. [Follow well-abandonment procedures of authorities having jurisdiction. Restore ground surface to finished grade.]

3.5 FIELD QUALITY CONTROL

A. Test Preparation: Clean water supply wells of foreign substances. Swab casings using alkalis, if necessary, to remove foreign substances.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. Plumbness and Alignment Testing: Comply with AWWA A100.
2. Furnish samples of water-bearing formation to testing laboratory and well-screen manufacturer for mechanical sieve analysis.
3. Prepare reports on static level of ground water, level of water for various pumping rates, and depth to water-bearing strata.
4. Performance Test Preparation: Start well pump and adjust controls and pressure setting. Replace damaged and malfunctioning controls and equipment.
5. Performance Testing: Conduct final pumping tests after wells have been constructed, cleaned, and tested for plumbness and alignment.

    a. Arrange to conduct tests, with seven days' advance notice, after test pump and auxiliary equipment have been installed. Note water-level elevations referred to for each assigned datum in wells.
    b. Provide discharge piping to conduct water to locations where disposal will not create a nuisance or endanger adjacent property. Comply with requirements of authorities having jurisdiction.
    c. Provide and maintain equipment of adequate size and type for measuring flow of water, such as weir box, orifice, or water meter.
    d. Measure elevation to water level in wells.
    e. Perform two bailer or air-ejection tests to determine expected yield. Test at depths with sufficient quantity of water to satisfy desired yields.
    f. Test Pump: Variable capacity test pump with capacity equal to maximum expected yields at pressure equal to drawdown in wells, plus losses in pump columns and discharge pipes.
    g. Start and adjust test pumps and equipment to required pumping rates.

h. Record readings of water levels in wells and pumping rates at [**30**] <**Insert number**>-minute maximum intervals throughout 24-hour minimum period.
i. Record maximum yields when drawdown is [**1500 mm (60 inches)**] <**Insert dimension**> above top of suction screens after designated times.
j. Operate pumping units continuously for [**eight**] <**Insert number**> hours after maximum drawdown is reached.
k. Record returning water levels in wells and plot curves of well recovery rates.
l. Remove sand, stones, and other foreign materials that may become deposited in wells after completing final tests.

D. Water Analysis Testing:

1. Engage a qualified testing agency to make bacteriological, physical, and chemical analyses of water from each finished well and report the results. Make analyses according to requirements of authorities having jurisdiction.

a. Bacteriological sample must include coliforms and total plate count (TPC).
b. Chemical sample must include ground water constituents and contaminants identified in EPA 570/9-75-001.

3.6 CLEANING

A. [Disinfect water supply wells according to AWWA A100 and AWWA C654 before testing well pumps.]

B. [Follow water supply well disinfection procedures required by authorities having jurisdiction before testing well pumps.]

3.7 PROTECTION

A. Water Quality Protection: Prevent well contamination, including undesirable physical and chemical characteristics.

B. [Ensure that mud pit will not leak or overflow into streams or wetlands. When well is accepted, remove mud and solids in mud pit from Project site and restore site to finished grade.]

C. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination; shut off contaminated water.

D. Exercise care to prevent breakdown or collapse of strata overlaying that from which water is to be drawn.

E. Protect water supply wells to prevent tampering and introducing foreign matter. Retain temporary well cap until installation is complete.

END OF SECTION 331117

SECTION 331414 – FIRE SERVICE MAINS AND APPURTENANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fire service mains for fire protection water service piping for dedicated building automatic sprinkler systems, and for fire service mains **[and the existing and re-purposed fire protection piping distribution]** for a dedicated fire hydrant system. **[This section also includes fire hydrants as appurtenances to the fire service mains.]** This Section only includes elements of the compound fire protection system outside of compound buildings.

B. Related Sections:

1. Section 033000 “Cast-in-Place Concrete.”
2. Section 211305 "Fire Sprinkler Systems" for wet-pipe fire-suppression sprinkler systems inside buildings.
3. Section 284626 “Addressable Fire Alarm Systems.”
4. Division 31 Section on earth moving.
5. Division 33 Section for common work results of piped utilities.
6. Section 331416 “Site Water Distribution Piping” for separate site water-service piping **[and combined water-service and fire-service piping]**.

1.2 STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B1.20.1, Pipe Threads, General Purpose (Inch).
2. ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250.
3. ASME B16.3, Malleable Iron Threaded Fittings, Classes 150 and 300.
4. ASME B16.4, Gray Iron Threaded Fittings, Classes 125 and 250.
5. ASME B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through 24.
6. ASME B16.9, Factory-Made Wrought Steel Butt weld Fittings.

B. American Society for Testing and Materials (ASTM):

1. ASTM A 234, Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated temperatures.
2. ASTM A 439, Specification for Schedule 80 CPVC Socket-Type Fittings.
3. ASTM D 2774, Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
4. ASTM F 437, Chlorinated Polyvinyl Chloride (CPVC) Specification for Schedule 80 CPVC Threaded Fittings.
5. ASTM F 438, Specification for Schedule 40 CPVC Socket-Type Fittings.

6. IEEE/ASTM-SI-10, Standard for Use of the International System of Units (SI): The Modern Metric System.
7. ASTM F 1674, Standard Test Method for Joint Restraint Products for Use with PVC Pipe.

C. American Water Works Association (AWWA):

1. AWWA C104, Cement Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110, Ductile Iron and Gray-Iron Fittings.
4. AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C115, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings.
7. AWWA C150, Thickness Design of Ductile-Iron Pipe.
8. AWWA C151, Ductile Iron Pipe, Centrifugally Cast.
9. AWWA C153, Ductile-Iron Compact Fittings.
10. AWWA C600, Installation of Ductile-Iron Mains and Their Appurtenances.
11. AWWA C602, Cement-Mortar Lining of Water Pipelines in Place – 100 mm (4 inch) and Larger.
12. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 100 – 1500 mm (4 - 60 inch).

D. National Fire Protection Association (NFPA):

1. NFPA 3, Recommended Practice for Commissioning of Fire Protection and Life Safety Systems, 2024 edition.
2. NFPA 4, Standard for Integrated Fire Protection and Life Safety System Testing, 2024 edition.
3. NFPA 13, Installation of Sprinkler Systems, 2022 edition.
4. NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances, 2022 edition.
5. NFPA 25, Standard for the Inspection, Testing and Maintenance of Water Based Fire Protection Systems, 2023 edtion.
6. NFPA 70, National Electric Code as amended by OBO in the OBO-ICS NEC.

E. Underwriters Laboratories (UL):

1. UL 246, Hydrants for Fire Protection Service.
2. UL 262, Gate Valves for Fire Protection Service.
3. UL 312, Check Valves for Fire Protection Service.
4. UL 789, Standard for Indicator Posts for Fire Protection Service.

F. Uni-Bell PVC Pipe Association (UBPPA):

1. UBPPA UNI-B-3, Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch).

1.3 SUBMITTALS

A. Product Data: Provide a complete manufacturer's product data for all products specified. Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for mechanically restrained and push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

1. Piping materials
2. Water distribution main piping, fittings, joints, valves, and coupling.
3. Bituminous coating for clamps and rods
4. Water service line piping, fittings, joints, valves, and coupling.
5. Hydrants
6. Indicator posts
7. Valve boxes

B. Certificates: Certificates must attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests must have been performed within three years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

1. Water distribution main piping, fittings, joints, valves, and coupling.
2. Water service line piping, fittings, joints, valves, and coupling.
3. Shop-applied lining and coating.
4. Lining.
5. Fire hydrants.
6. Flushing of system.

C. Manufacturer's Instructions

1. Installation procedures for water piping.

D. Shop Drawings:

1. Pipe joint and pipe joining coupling construction and installation details.
2. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
3. Wiring Diagrams: For power, signal, and control wiring.

E. Field quality-control reports, including digital pictures and associated marked-up drawings.

1.4 QUALITY ASSURANCE

A. Acceptance of fire service mains and their appurtenances must be by OBO/OPS/FIRE in conjunction with Project Director/COR.

B. Manufacturer Qualifications: All components of the fire service main must be supplied by a U.S. manufacturer. There must be no deviations from this requirement except by written approval from OBO/OPS/FIRE/FPE through the project director/COR.

C. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

D. Comply with requirements of the Post Facility Management Water Treatment Plant Operations Office supplying water, including tapping of water mains and backflow prevention.

E. Piping materials must bear label, stamp, or other markings of a nationally recognized testing laboratory (NRTL) or a specified testing agency. All materials must be UL listed, FM approved or AWWA recognized for Fire-Protection Service.

F. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO-ICS NEC by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

G. Comply with the "Approval Guide," published by FM Global, or UL's "Fire Protection Equipment Directory" for fire-service-main products.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves and all piping joining and fitting components, including fire hydrants, according to the following:

1. Ensure that valves and all piping joining and fitting components are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 [PROJECT CONDITIONS

A. Interruption of Existing Fire-Suppression Water-Service Piping: Do not interrupt service to existing buildings and facilities on the Embassy Compound unless permitted under the following conditions, and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Project Director/COR no fewer than five days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without written permission from Project Director/COR.]

1.7 [COORDINATION

A. Coordinate connection to existing water mains with Project Director/COR and Post Facilities Maintenance Water Treatment Plant Operations Office company.]

1.8 WARRANTY

A. Contractor's Warranty: Submit a written warranty agreeing to repair or replace any portion of the automatic sprinkler system that fails in materials or workmanship within a period of one year after the latter of substantial completion or final acceptance testing of the underground fire main installation, which is witnessed by OBO/OPS/FIRE.

B. Hydrants: Provide standard manufacturer's written warranty, without monetary limitation, signed by manufacturer agreeing to promptly repair or replace products that fail in materials or workmanship under normal and customary use and maintenance for the following period:

1. Warranty Period: 25 years from Substantial Completion.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.

C. Grooved-End, Ductile-Iron Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anvil International, Inc.
b. Shurjoint Piping Products.
c. Star Pipe Products.
d. Victaulic Company.

2. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. EBAA Iron, Inc.
b. Anvil International, Inc.
c. Shurjoint Piping Products.
d. Star Pipe Products.

E. Push-on-Joint, Ductile-Iron Fittings: AWWA C153, ductile-iron compact pattern.

1. Gaskets: AWWA C111, rubber.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. EBAA Iron, Inc.

b. Anvil International, Inc.
c. Shurjoint Piping Products.
d. Star Pipe Products.

F. Flanges: ASME B16.1, Class 125, cast iron.

2.2 PVC PIPE AND FITTINGS

A. PVC Pipe: AWWA C900 or UL 1285, Class 200, with bell end with gasket, and with spigot end.

B. PVC Pipe: AWWA C900 or UL 1285, Class 200, plain end pipe.

C. PVC Fittings: AWWA C900 or UL 1285, Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell. All mechanical restraints must be supplied by a single supplier/manufacturer and must meet the test requirements of Uni-Bell Specification Uni-B-13, "Uni-Bell PVC Pipe Association.

D. Mechanical Joint Restraint for PVC Pipe:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. EBAA Iron, Inc.
b. ROMAC Industries Inc.
c. Star Pipe Products.

2. Description: Restraint devices for mechanical joint fittings and appurtenances conforming to ANSI/AWWA C153/A2153. Restraint devices for nominal pipe sizes 100 mm to 250 mm must consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. Mechanical joint restraints must be UL listed and FM Global Approved and must meet or exceed the requirements of ASTM F1674. Restraint devices and associated components must employ an epoxy-based corrosion resistant coating system or approved equivalent.
3. Pressure Rating: 1725 kPa (250 psi) minimum.

E. Restrained Coupling for PVC Pipe:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. EBAA Iron, Inc.
b. ROMAC Industries Inc.
c. Star Pipe Products.

2. Description: Restrained coupling system for use in joining and restraining two plain end pipes of the same or dissimilar materials. The restraint mechanism must incorporate individually actuating gripping surfaces to maximize restraint capability and have torque limiting twist off nuts to insure proper actuating of restraint devices. The coupling sleeve internal surfaces must be lined with fusion bonded epoxy conforming to ANSI/AWWA C213 and sealing gaskets must be constructed of EPDM. The system must meet applicable requirements of ANSI/AWWA C116, ANSI/AWWA C111, ASTM A536 and ASTM D2000. Restraint devices and associated components must employ an epoxy-based corrosion resistant coating system or approved equivalent.
3. Pressure Rating: 1725 kPa (250 PSI) minimum.

2.3 SPECIAL PIPE FITTINGS

A. Ductile-Iron Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. EBAA Iron, Inc.
   b. ROMAC Industries Inc.
   c. Star Pipe Products.

2. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
3. Pressure Rating: 1725 kPa (250 psig) minimum.

B. Ductile-Iron Deflection Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. EBAA Iron, Inc.
   b. ROMAC Industries, Inc.
   c. Star Pipe Products

2. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
3. Pressure Rating: 1725 kPa (250 psig) minimum.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: High-density, cross-laminated PE film of 0.10-mm (0.004-inch) minimum thickness.

C. Form: Sheet.

D. Color: Natural.

2.5 JOINING MATERIALS

A. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.

2.6 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; Dresser Piping Specialties.
   c. Ford Meter Box Company, Inc. (The); Pipe Products Division.
   d. JCM Industries.
   e. ROMAC Industries Inc.
   f. Smith-Blair, Inc.; a Sensus company.
   g. Viking Johnson.

2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.
3. Standard: AWWA C219.
4. Center-Sleeve Material: Ductile iron.
5. Gasket Material: Natural or synthetic rubber.
6. Pressure Rating: 1380 kPa (200 psig) minimum.
7. Metal Component Finish: Corrosion-resistant coating or material.

2.7 GATE VALVES

A. All underground gate valves must be epoxy coated.

B. AWWA Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. American AVK Company; Valves & Fittings Division.
   b. American Cast Iron Pipe Company; American Flow Control Division.
   c. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Kennedy Valve; a division of McWane, Inc.
   f. M&H Valve Company; a division of McWane, Inc.
   g. Mueller Co.; Water Products Division.
   h. U.S. Pipe.

2. 1380-kPa (200-psig), AWWA, Iron, OS&Y, Metal-Seated Gate Valves:

   a. Description: Cast- or ductile-iron body and bonnet; with cast-iron double disc, bronze disc and seat rings, and bronze stem.
   b. Standard: AWWA C500.
   c. Pressure Rating: 1380 kPa (200 psig).
   d. End Connections: Flanged or grooved.

3. 1380-kPa (200-psig), AWWA, Iron, OS&Y, Resilient-Seated Gate Valves:

   a. Description: Cast- or ductile-iron body and bonnet; with bronze, gray-iron, or ductile-iron gate; resilient seats; and bronze stem.
   b. Standard: AWWA C509.
   c. Pressure Rating: 1380 kPa (200 psig).
   d. End Connections: Flanged or grooved.

4. 1725-kPa (250-psig), AWWA, Iron, OS&Y, Resilient-Seated Gate Valves:

   a. Description: Cast- or ductile-iron body and bonnet; with bronze, gray-iron, or ductile-iron gate; resilient seats; and bronze stem.
   b. Standard: AWWA C509.
   c. Pressure Rating: 1380 kPa (200 psig).
   d. End Connections: Flanged or grooved.

C. UL-Listed or FM-Approved Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. American AVK Company; Valve & Fittings Division.
   b. American Cast Iron Pipe Company; American Flow Control Division.
   c. American Cast Iron Pipe Company; Waterous Company Subsidiary.

d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kennedy Valve; a division of McWane, Inc.
f. M&H Valve Company; a division of McWane, Inc.
g. Mueller Co.; Water Products Division.
h. Tyco Fire & Building Products LP.
i. United Brass Works, Inc.
j. U.S. Pipe.

2. 1200-kPa (175-psig), UL-Listed or FM-Approved, Iron, Nonrising-Stem Gate Valves:

a. Description: Iron body and bonnet, bronze seating material, and inside screw.
b. Standards: UL 262 and "Approval Guide," published by FM Global, listing.
c. Pressure Rating: 1200kPa (175 psig) minimum.
d. End Connections: Mechanical or push-on joint.
e. Indicator-Post Flange: Include on valves used with indicator posts.

3. 1725-kPa (250-psig), UL-Listed or FM-Approved, Iron, Nonrising-Stem Gate Valves:

a. Description: Iron body and bonnet, bronze seating material, and inside screw.
b. Standards: UL 262 and "Approval Guide," published by FM Global, listing.
c. Pressure Rating: 1725 kPa (250 psig) minimum.
d. End Connections: Mechanical or push-on joint.
e. Indicator-Post Flange: Include on valves used with indicator posts.

4. 1200-kPa (175-psig), UL-Listed or FM-Approved, Iron, OS&Y, Gate Valves:

a. Description: Iron body and bonnet and bronze seating material.
b. Standards: UL 262 and "Approval Guide," published by FM Global, listing.
c. Pressure Rating: 1200 kPa (175 psig) minimum.
d. End Connections: Flanged or grooved.

5. 1725-kPa (250-psig), UL-Listed or FM-Approved, Iron, OS&Y Gate Valves:

a. Description: Iron body and bonnet and bronze seating material.
b. Standards: UL 262 and "Approval Guide," published by FM Global, listing.
c. Pressure Rating: 1725 kPa (250 psig) minimum.
d. End Connections: Flanged or grooved.

6. UL-Listed or FM-Approved, OS&Y Bronze, Gate Valves:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Crane Co.; Crane Valve Group; Stockham Division.
3) Milwaukee Valve Company.
4) NIBCO INC.

5) United Brass Works, Inc.

b. Description: Bronze body and bonnet and bronze stem.
c. Standards: UL 262 and "Approval Guide," published by FM Global, listing.
d. Pressure Rating: 1200 kPa (175 psig) minimum.
e. End Connections: Threaded.

2.8 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. Kennedy Valve; a division of McWane, Inc.
c. M&H Valve Company; a division of McWane, Inc.
d. Mueller Co.; Water Products Division.
e. U.S. Pipe.

2. Description: Sleeve and valve compatible with drilling machine.
3. Standard: MSS SP-60.
4. Tapping Sleeve: Cast-iron, ductile-iron, or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Sleeve must match size and type of pipe material being tapped and have recessed flange for branch valve.
5. Valve: AWWA, cast-iron, non-rising stem, metal-seated gate valve with one raised-face flange mating tapping-sleeve flange.

B. Indicator Posts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American AVK Company; Valves & Fittings Division.
b. American Cast Iron Pipe Company; American Flow Control Division.
c. American Cast Iron Pipe Company; Waterous Company Subsidiary.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kennedy Valve; a division of McWane, Inc.
f. Mueller Co.; Water Products Division.
g. NIBCO INC.
h. Tyco Fire & Building Products LP.

2. Description: Vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.
3. Standards: UL 789 and "Approval Guide," published by FM Global, listing.

2.9 CHECK VALVES

A. All underground check valves must be epoxy coated.

B. AWWA Check Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. American AVK Company; Valves & Fittings Division.
   b. American Cast Iron Pipe Company; American Flow Control Division.
   c. APCO Willamette Valve and Primer Corporation.
   d. Crane Co.; Crane Valve Group; Stockham Division.
   e. Kennedy Valve; a division of McWane, Inc.
   f. M&H Valve Company; a division of McWane, Inc.
   g. Mueller Co.; Water Products Division.
   h. NIBCO INC.

2. Description: Swing-check type with resilient seat; with interior coating according to AWWA C550 and ends to match piping.
3. Standard: AWWA C508.
4. Pressure Rating: 1200 kPa (175 psig).

C. UL-Listed or FM-Approved Check Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Globe Fire Sprinkler Corporation.
   d. Kennedy Valve; a division of McWane, Inc.
   e. Mueller Co.; Water Products Division.
   f. NIBCO INC.
   g. Tyco Fire & Building Products LP.
   h. United Brass Works, Inc.
   i. Victaulic Company.
   j. Viking Corporation.

2. Description: Swing-check type with pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.
3. Standards: UL 312 and "Approval Guide," published by FM Global, listing.
4. Pressure Rating: 1725 kPa (250 psig).

2.10 DETECTOR CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
2. Badger Meter, Inc.
3. FEBCO; SPX Valves & Controls.
4. Kennedy Valve; a division of McWane, Inc.
5. Mueller Co.; Hersey Meters Division.
6. Victaulic Company.
7. Viking Corporation.

B. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

C. Standards: UL 312 and "Approval Guide," published by FM Global, listing.

D. Pressure Rating: 1200 kPa (175 psig).

E. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.11 PRESSURE-REDUCING VALVES

A. Water Control Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide CLA-VAL Model 90A-21; or comparable product by one of the following:

   a. CLA-VAL Automatic Control Valves.
   b. Flowmatic Corporation.
   c. OCV Control Valves.
   d. Watts Regulator Company; Ames Fluid Control Systems.
   e. Watts Regulator Company; Watts ACV Division.

2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with UL listed, FM Global or AWWA C550 approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
3. Pressure Rating: Initial pressure of 1035 kPa (150 psig) minimum.
4. Main Valve Body: Cast or ductile iron with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

   a. Size: 250 mm.
   b. Pattern: Globe-valve design.
   c. Trim: Stainless steel.

5. Design Flow Rate: 11,350 LPM.
6. Design Inlet Pressure: 12 Bar.
7. Design Outlet Pressure Setting: 6.2 Bar.
8. End Connections: Threaded for DN 50 (NPS 2) and smaller; flanged for DN 65 (NPS 2-1/2) and larger.

2.12 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. FEBCO; SPX Valves & Controls.
   d. Flowmatic Corporation.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Wilkins Water Control Products Division.

2. Standard: UL 262.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 35 kPa (5 psig) maximum, through middle one-third of flow range.
5. Size: 250 mm.
6. Selected Unit Flow Range Limits: 11350 LPM.
7. Pressure Loss at Design Flow Rate: 0.5 Bar for DN 65 (NPS 2-1/2) and larger.
8. Body Material: Bronze for DN 50 (NPS 2) and smaller; cast iron with interior lining complying with AWWA C550 for DN 65 (NPS 2-1/2) and larger.
9. End Connections: Flanged for DN 65 (NPS 2-1/2) and larger.
10. Configuration: Designed for horizontal, straight through flow.
11. Accessories: Ball valves with threaded ends on inlet and outlet of DN 50 (NPS 2) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of DN 65 (NPS 2-1/2) and larger.

B. Backflow Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Conbraco Industries, Inc.; Apollo Valves.
   b. FEBCO; SPX Valves & Controls.
   c. Flowmatic Corporation.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Wilkins Water Control Products Division.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.13 CONCRETE VAULTS

A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857, and made according to ASTM C 858.

B. Ladder: ASTM A 36/A 36M, steel ladder; or PE-encased steel steps.

C. Manhole: ASTM A 48/A 48M, Class No. 35A minimum tensile strength, gray iron traffic frame and cover.

1. Dimension: 60-mm (24-inch) minimum diameter unless otherwise indicated.

D. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.

1. Dimension: 600-mm (24-inch) minimum diameter unless otherwise indicated.

E. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.14 FIRE HYDRANTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide AVK Series 2780; or comparable product by one of the following:

1. American Cast Iron Pipe Company; American Flow Control Division.
2. American Cast Iron Pipe Company; Waterous Company Subsidiary.
3. American Foundry Group, Inc.
4. Kennedy Valve; a division of McWane, Inc.
5. M&H Valve Company; a division of McWane, Inc.
6. Mueller Co.; Water Products Division.
7. U.S. Pipe.
8. Sigelock Systems LLC

B. Hydrant Materials and Coatings: Comply with NSF61 (Drinking Water Systems Components - Health Effects) and NSF372 (Drinking Water System Components - Lead Content) standards.

C. Performance Requirements: Hydrants must conform to ANSI/AWWA C502 Standard for Dry-Barrel Fire Hydrants.

D. Working Pressure Rating: Hydrants must be rated for 300 psig working pressure and must withstand hydrostatic tests for shell and seat leakage at pressures up to 600 psig.

E. Tested Design: Hydrants must have been tested for compliance with Underwriters Laboratories standards UL246 for operation, leakage, body strength, head loss, operating torque, nonmetallic materials aging.

F. Hydrant must impede unauthorized access to all nozzles and operating nut

G. Bolts and Nuts: Stainless steel.

H. Hydrant Finish: Factory-applied polyester powder coating.

I. General Description: Hydrant must have single-cast ductile iron body with three recessed nozzle outlets; one 115 mm (4-1/2 inch) pumper connection, and two 65 mm (2-1/2 inch) hand line hose connections. Hydrant must have integrated boltless head.

J. Hydrant must have a 130 mm (5-1/4 inch) main valve opening size. Hydrants must meet or exceed performance requirements of ANSI/AWWA C502 Standard for Dry-Barrel Fire Hydrants.

K. Shoe Connections: Coated in accordance with ANSI/AWWA C550 Protective Coatings for Valves and Hydrants.

L. Inlets: Conform to the requirements of Section 3.2.18 of ANSI/AWWA C502 Standard for Dry-Barrel Fire Hydrants.

M. Mechanical Joint Bell Dimensions: Conform to ANSI/AWWA C111/A21.11.

N. Hydrant wrench must fit all manufacturers' standard fire hydrant nozzle cap lugs and operating nuts when any additional security features are removed from any competitor's hydrant.

O. Operating Stem: 304 stainless steel.

P. Seat Ring and Valve Top Plate: 304 stainless steel.

Q. Barrel Interior: Powder coated finish.

R. Outlet Threads: Either thread must be compatible with local fire department hose threads, or an adapter attachment must be provided that is compatible with local fire service hose treads.

2.15 ALARM DEVICES

A. General: UL 753 and "Approval Guide," published by FM Global, listing, of types and sizes to mate and match piping and equipment.

B. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Division 31 Section on earth moving.

3.2 PIPING INSTALLATION

A. Comply with all requirements in Division 33 Section for common work results of piped utilities.

B. Water-Main Connection: Carefully remove materials so as to not damage material which is to remain. Replace existing work damaged by the Contractors' operations with new work of the same construction.

C. Water-Main System Installation: Equipment, materials, workmanship, fabrication, assembly, installation, examination, inspection and testing must be in accordance with NFPA 24, except as modified herein.

D. Underground Piping: Installation of underground piping and fittings must conform to NFPA 24. Joints must be anchored in accordance with NFPA 24. Concrete thrust block must be provided at elbow where pipe turns up toward the floor, and the pipe riser must be restrained with steel rods from the elbow to the flange above the floor. After installation, in accordance with NFPA 24, rods and nuts must be thoroughly cleaned and coated with bituminous material and wrapped, or other corrosion-resistant material identified in this Section and approved by Project Director/COR. Minimum depth of cover must be 900 mm (36 inches), and 305mm (12 inches) below frost line.

E. Comply with NFPA 24 for fire-service-main piping materials and installation.

F. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

G. Install exterior encasement to completely encase buried ductile iron pipelines with polyethylene sheet according to ASTM A 674 or AWWA C105.

H. Piping must be inspected, tested, photo documented, and approved before burying, covering or concealing.

I. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23. Install a continuous length of tracer wire for the full length of each run of non-metallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

J. Bury piping with depth of cover in accordance with project drawings and maintain a minimum depth of at least 900 mm (36 inches), and 305mm (12 inches) below frost line as required by NFPA 24.

K. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

L. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated in project drawings.

1. Terminate fire-suppression water-service piping at building floor slab. Terminate piping with caps, plugs, or flanges as required for piping material and to provide provisions for flushing. Make connections to building's fire-suppression water-service piping systems upon completion and acceptance of flushing and hydrostatic testing.

M. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

N. Comply with requirements in Section 211305, "Fire Sprinkler Systems" for fire-suppression-water piping inside the building.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.

B. Install flanges, flange adaptors, or couplings for grooved-end piping on valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.

C. Ream ends of tubes and remove burrs.

D. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.

E. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

F. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.

G. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.

H. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139.

I. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

J. Do not use flanges or unions for underground piping.

3.4 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.

B. Install anchorages for tees, plugs, and caps, bends, crosses, valves, and hydrant branches in fire-suppression water-service piping according to NFPA 24 and the following:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.5 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL-Listed or FM-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL-Listed or FM-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Pressure-Reducing Valves: Install in vault between shutoff valves. Install full-size valved bypass.

G. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Section 033000 on “Cast-in-Place Concrete.”

H. Sectional valve must be installed adjacent to a fitting that branches off to serve individual building.

3.6 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support DN 65 (NPS 2-1/2) and larger backflow preventers and piping on concrete piers. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete."

3.7 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

3.8 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top approximately 50 mm (2 inches) above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.9 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. UL-Listed or FM-Approved Fire Hydrants: Comply with NFPA 24.

3.10 ALARM DEVICE INSTALLATION

A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
3. Tamper switch on valve tamper cover not permitted.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.
2. Post Indicators: Install padlock on wrench on indicator post.

D. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Section 284626 “Addressable Fire-Alarm Systems.”

3.11 CONNECTIONS

A. Connect fire-suppression water-service piping to existing water main. Use tapping sleeve and tapping valve.

B. Connect fire-suppression water-service piping to interior fire-suppression piping. The connection must not be made until all underground pipes have been flushed, tested, and certified by OBO/OPS/FIRE.

C. Connect waste piping from concrete vault drains to storm-drainage system. Comply with requirements in Division 33 Section on site storm utility drainage piping for connection to storm sewer.

3.12 FIELD QUALITY CONTROL

A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.

B. Piping Tests:

1. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently.
2. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
3. Take digital pictures of each joint and each thrust blocks throughout each stage of installation. Number and label each picture keyed to a set of marked-up drawings. These marked-up drawing must be scanned and kept with digital images, and must submitted to OBO/OPS/FIR through the Project Director/COR.

C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.

1. Increase pressure in 350-kPa (50-psig) increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 kPa (0 psig). Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 1.89 L (2 quarts) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Completely flush the system and certify in accordance with NFPA 24. and provide certification document to OBO/OPS/FIR through the Project Director/COR.

E. Prepare test and inspection reports.

3.13 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section on earth moving.

B. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel.

C. Post underground main drawing in picture type frame in fire pump room showing valve lineup external to building for use in an emergency.

D. Provide permanent tag/label for each valves and access cover identifying its purpose.

3.14 CLEANING

A. Clean and disinfect fire-suppression water-service piping as follows:

1. Purge new piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by Project Director/COR based upon input from OBO/OPS/FIRE and OBO/PDCS/DE/ME or, if method is not prescribed, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by OBO/OPS/FIRE and OBO/PDCS/DE/ME through the Project Director/COR or, if method is not prescribed, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for three hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to Project Director/COR, who will contact OBO/PDCS/DE/ME for input on handling samples and data. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

3.15 PIPING SCHEDULE

A. Underground Fire Service Water Piping: DN 100 (NPS 4). Must be one of the following:

1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
2. PVC, Class 200 pipe listed for fire-protection service; mechanical-joint, ductile iron, compact-pattern fittings; glands, gaskets and bolts; and gasketed joints.

B. Underground fire-suppression water-service piping NPS 6 to NPS 10 (DN 150 to DN 250) must be one of the following:

1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
2. PVC, Class 200 pipe listed for fire-protection service; mechanical-joint, ductile iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.

C. Vault fire-suppression water-service piping NPS 6 to NPS 10 (DN 100 to DN 250) must be grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.

D. Under slab fire-suppression water-service piping NPS 4 to NPS 10 (DN 100 to DN 250) must be one of the following:

1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and restrained, gasketed joints.

3.16 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

B. Vault fire-suppression water-service shutoff valves DN 50 (NPS 2) and smaller must be UL-listed or FM-approved, OS&Y, bronze, gate valves.

C. Indicator-post underground fire-suppression water-service valves DN 100 (NPS 4) and larger must be 1200-kPa (175-psig), UL-listed or FM-approved, iron, non-rising-stem gate valves with indicator-post flange.

D. Standard-pressure, aboveground and vault fire-suppression water-service shutoff valves DN 100 (NPS 4) and larger must be one of the following:

1. 1200-kPa (175-psig), UL-listed or FM-approved, iron, OS&Y gate valves.

E. Fire-suppression water-service check valves DN 100 (NPS 4) and larger must be one of the following:

1. UL-listed or FM-approved detector check valves.

END OF SECTION 331414

SECTION 331416 – SITE WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside compound buildings for water service **[, and combined water service and fire-service mains]**. This following water-distribution piping is included in this Section:

1. **[Piping from municipal source, through or near compound Water Demarc Room, to compound raw water storage tanks.]**
2. **[Piping from on-compound wells to compound raw water storage tanks.]**
3. **[Piping of trucked water received at compound perimeter to compound raw water storage tanks.]**
4. Piping from the compound potable water storage tank to the domestic piping for each building.
5. Utility water meter at compound perimeter.

B. Related Sections include the following:

1. Division 22 Section on "Sleeves and Sleeve Seals for Plumbing Piping" for requirements also applicable to compound water-service piping.
2. Division 22 Section on "Domestic Water Piping" for water-distribution piping serving each individual compound building.
1. **[Division 22 Section "Domestic Water Piping" for post data metering at each individual compound building.]**
2. Section 223230 "Potable Water Treatment" for compound treatment of water stored in compound raw water tanks prior to distribution to each individual compound building.
3. Section 260518 "Low-Voltage Electrical Power Conductors and Cables" for connection of wiring.
4. Section 260525 "Grounding and Bonding for Electrical Systems" for equipment grounding.
5. Division 31 Section on "Earth Moving" for excavating, trenching, and backfilling.
6. **[Division 33 Section on "Common Work Results for Utilities" for piping-system requirements that are common for compound utility piping.]**
7. Section 331414 "Fire Service Mains and Appurtenances" for separate fire-service site distribution.

1.2 DEFINITIONS

A. BBL: Building battery limit. This identifies the transition location for engineering systems from the site utilities to building systems. The baseline for this transition point is 1.5 meters outside of the building wall for each building.

B. EPDM: Ethylene propylene diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. PA: Polyamide (nylon) plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

H. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

I. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1. Wiring Diagrams: Power, signal, and control wiring for alarms.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Local Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of the OBO-ICS IPC and local authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

B. Piping materials must bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with Chapter 1 of the OBO-ICS NEC by a testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE/EE and marked for intended use.

D. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

E. [Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products where applicable.]

F. [NFPA Compliance: For piping and components jointly used for site fire-suppression distribution, comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

1. Potable-water piping and components must comply with NSF 14, NSF 61, and NSF 372. [Include marking "NSF-pw" on piping.].]

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves **[, including fire hydrants,]** according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves **[, including fire hydrants,]** according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves **[and fire hydrants]** if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 [PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only

after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Project Director/COR no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Project Director/COR's written permission.]

1.7 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in Article on PIPING APPLICATION for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: [**ASTM B88M, Type A**] [**and**] [**ASTM B88M, Type B**], water tube, annealed temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

B. Hard Copper Tube: [**ASTM B88M, Type A**] [**and**] [**ASTM B88M, Type B**], water tube, drawn temper.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

D. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

E. Copper or Bronze, Pressure-Seal-Joint Fittings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Viega; Plumbing & Heating Systems.

2. DN 50 (NPS 2) and Smaller: Wrought-copper with EPDM O-ring seal in each end.
3. DN 65 to DN 100 (NPS 2-1/2 to NPS 4): Bronze fitting with stainless steel grip ring and EPDM O-ring seal in each end.
4. Minimum 1400-kPa (200-psig) working-pressure rating at 120 deg C (250 deg F).

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances:

   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) Anvil International, Inc.
      2) Victaulic Company of America.

   b. Grooved-End, Ductile-Iron Fittings: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe.
   c. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.4 PE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than [**1100 kPa (160 psig)**] [**1400 kPa (200 psig)**].

1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than [**1100 kPa (160 psig)**] [**1400 kPa (200 psig)**].

1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than [**1100 kPa (160 psig)**] [**1400 kPa (200 psig)**].

2.5 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.

1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

B. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

C. PVC, AWWA Pipe: AWWA C900, [**Class 150**] [**and**] [**Class 200**], with bell end with gasket, and with spigot end.

1. [Comply with UL 1285 for fire-service mains if indicated.]
2. PVC Fabricated Fittings: AWWA C900, [**Class 150**] [**and**] [**Class 200**], with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Gaskets: AWWA C111, rubber.

5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.6 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. EBAA Iron, Inc.
b. U.S. Pipe and Foundry Company.

2. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Pressure Rating: 1700 kPa (250 psig) minimum.
b. Expansion Required: <**Insert mm (inches)**>.

B. Ductile-Iron Flexible Expansion Joints:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. EBAA Iron, Inc.
b. Hays Fluid Controls; a division of ROMAC Industries Inc.
c. Star Pipe Products.

2. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Pressure Rating: 1700 kPa (250 psig) minimum.
b. Offset: <**Insert mm (inches)**>.
c. Expansion Required: <**Insert mm (inches)**>.

C. Ductile-Iron Deflection Fittings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. EBAA Iron, Inc.

2. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with

AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Pressure Rating: 1700 kPa (250 psig) minimum.

2.7 JOINING MATERIALS

A. [Refer to Division 33 Section on "Common Work Results for Utilities" for commonly used joining materials.]

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.8 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Dresser Piping Specialties.
c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
d. Hays Fluid Controls; a division of ROMAC Industries Inc.
e. JCM Industries.
f. Smith-Blair, Inc.
g. Viking Johnson.

2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

a. Standard: AWWA C219.
b. Center-Sleeve Material: [**Manufacturer's standard**] [**Carbon steel**] [**Stainless steel**] [**Ductile iron**] [**Malleable iron**].
c. Gasket Material: Natural or synthetic rubber.
d. Pressure Rating: [**1000 kPa (150 psig)**] [**1350 kPa (200 psig)**] <**Insert pressure**> minimum.
e. Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Victaulic Depend-O-Lok.

2. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

   a. Standard: AWWA C219.
   b. Sleeve Material: [**Manufacturer's standard**] [**Carbon steel**] [**Stainless steel**].
   c. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
   d. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
   e. Pressure Rating: **[1000 kPa (150 psig)] [1350 kPa (200 psig)] <Insert pressure>** minimum.
   f. Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

E. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

   a. Description:

      1) Standard: ASSE 1079.
      2) Pressure Rating: 1700 kPa (250 psig) minimum working pressure at 80 deg C (180 deg F).
      3) Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
      4) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

   a. Description:

      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.

3) Working Pressure Rating: **[1000 kPa (150 psig)] [2000 kPa (300 psig)]** minimum to suit system pressures.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: **[1000 kPa (150 psig)]** <**Insert pressure**>.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple complying with ASTM F1545.
3) Pressure Rating: 2000 kPa (300 psig) at 105 deg C (225 deg F).
4) End Connections: Male threaded, plain, or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.9 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A674 or AWWA C105.
2. Form: [**Sheet**] [**Sheet or tube**] [**Tube**].
3. Material: As identified in the Drawings, or otherwise one of the following:

a. LLDPE film of 0.20-mm (0.008-inch) minimum thickness.
b. LLDPE film of 0.20-mm (0.008-inch) minimum thickness, or high-density, cross-laminated PE film of 0.10-mm (0.004-inch) minimum thickness.
c. High-density, cross-laminated PE film of 0.10-mm (0.004-inch) minimum thickness.

4. Color: [**Black**] [**Natural**] <**Insert color**>.

2.10 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. American AVK Co.; Valves & Fittings Div.
    b. American Cast Iron Pipe Co.; American Flow Control Div.
    c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. East Jordan Iron Works, Inc.
    f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
    g. McWane, Inc.; Kennedy Valve Div.
    h. McWane, Inc.; M & H Valve Company Div.
    i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
    j. Mueller Co.; Water Products Div.
    k. NIBCO INC.
    l. U.S. Pipe and Foundry Company.

2. Non-rising-Stem, Metal-Seated Gate Valves:

    a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.

        1) Standard: AWWA C500.
        2) Minimum Pressure Rating: 1400 kPa (200 psig).
        3) End Connections: Mechanical joint.
        4) Interior Coating: Complying with AWWA C550.

3. Non-rising-Stem, Resilient-Seated Gate Valves:

    a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

        1) Standard: AWWA C509.
        2) Minimum Pressure Rating: 1400 kPa (200 psig).
        3) End Connections: Mechanical joint.
        4) Interior Coating: Complying with AWWA C550.

4. Non-rising-Stem, High-Pressure, Resilient-Seated Gate Valves:

    a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

        1) Standard: AWWA C509.
        2) Minimum Pressure Rating: 1700 kPa (250 psig).
        3) End Connections: Push on or mechanical joint.
        4) Interior Coating: Complying with AWWA C550.

5. OS&Y, Rising-Stem, Metal-Seated Gate Valves:

a. Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.

1) Standard: AWWA C500.
2) Minimum Pressure Rating: 1400 kPa (200 psig).
3) End Connections: Flanged.

6. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 1400 kPa (200 psig).
3) End Connections: Flanged.

B. UL/FMG, Cast-Iron Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Cast Iron Pipe Co.; American Flow Control Div.
b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
e. McWane, Inc.; Kennedy Valve Div.
f. McWane, Inc.; M & H Valve Company Div.
g. Mueller Co.; Water Products Div.
h. NIBCO INC.
i. U.S. Pipe and Foundry Company.

2. UL/FMG, Non-rising-Stem Gate Valves:

a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 1200 kPa (175 psig).
3) End Connections: Flanged.

3. [OS&Y, Rising-Stem Gate Valves:

a. Description: Iron body and bonnet and bronze seating material.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 1200 kPa (175 psig).
3) End Connections: Flanged.]

C. Bronze Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corporation.

2. OS&Y, Rising-Stem Gate Valves:

a. Description: Bronze body and bonnet and bronze stem.

1) Standards: UL 262 and FMG approved.
2) Minimum Pressure Rating: 1200 kPa (175 psig).
3) End Connections: Threaded.

3. Non-rising-Stem Gate Valves:

a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.

1) Standard: MSS SP-80.

2.11 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers:

a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
b. East Jordan Iron Works, Inc.
c. Flowserve.
d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
e. McWane, Inc.; Kennedy Valve Div.
f. McWane, Inc.; M & H Valve Company Div.
g. Mueller Co.; Water Products Div.
h. U.S. Pipe and Foundry Company

2. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60.

b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c. Valve: AWWA, cast-iron, non-rising-stem, [**metal**] [**resilient**]-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 125 mm (5 inches) in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.12 CHECK VALVES

A. AWWA Check Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American AVK Co.; Valves & Fittings Div.
b. American Cast Iron Pipe Co.; American Flow Control Div.
c. APCO Williamette; Valve and Primer Corporation.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
g. McWane, Inc.; Kennedy Valve Div.
h. McWane, Inc.; M & H Valve Company Div.
i. Mueller Co.; Water Products Div.
j. NIBCO INC.
k. Watts Water Technologies, Inc.

2. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.

a. Standard: AWWA C508.
b. Pressure Rating: 1200 kPa (175 psig).

B. UL/FMG, Check Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
b. Crane Co.; Crane Valve Group; Stockham Div.
c. Globe Fire Sprinkler Corporation.
d. Kidde Fire Fighting.
e. MATCO-NORCA, Inc.
f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
g. McWane, Inc.; Kennedy Valve Div.
h. Mueller Co.; Water Products Div.
i. NIBCO INC.
j. Reliable Automatic Sprinkler Co., Inc.
k. Tyco Fire & Building Products.
l. United Brass Works, Inc.
m. Victaulic Company of America.
n. Viking Corporation.
o. Watts Water Technologies, Inc.

2. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.

a. Standards: UL 312 and FMG approved.
b. Pressure Rating: [**1200 kPa (175 psig)**] [**1700 kPa (250 psig)**].

2.13 DETECTOR CHECK VALVES

A. Detector Check Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Ames Fire & Waterworks; a division of Watts Regulator Co.
b. Badger Meter, Inc.
c. FEBCO; SPX Valves & Controls.
d. Globe Fire Sprinkler Corporation.
e. McWane, Inc.; Kennedy Valve Div.
f. Mueller Co.; Hersey Meters.
g. Victaulic Company of America.
h. Viking Corporation.
i. Watts Water Technologies, Inc.

2. Description: Of type identified in Drawings, or otherwise as selected from the following:

a. Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 1200 kPa (175 psig).
3) Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

b. Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.

1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 1200 kPa (175 psig).

2.14 BALL VALVES

A. Bronze Ball Valves, Two-Piece:

1. Minimum Pressure Rating: 2750 kPa (400 psig).
2. Ends: Threaded.

2.15 BUTTERFLY VALVES

A. AWWA Butterfly Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. DeZURIK/Copes-Vulcan; a unit of SPX Corporation.
b. Milliken Valve Company.
c. Mosser Valve; a division of Olson Technologies, Inc.
d. Mueller Co.; Water Products Div.
e. Pratt, Henry Company.
f. Val-Matic Valve & Manufacturing Corp.

2. Description: Rubber seated.

a. Standard: AWWA C504.
b. Body: Cast or ductile iron.
c. Body Type: [**Wafer**] [**Wafer or flanged**] [**Flanged**].
d. Pressure Rating: 1000 kPa (150 psig).

B. UL Butterfly Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. McWane, Inc.; Kennedy Valve Div.
b. Milwaukee Valve Company.
c. Mueller Co.; Water Products Div.
d. NIBCO INC.
e. Pratt, Henry Company.

2. Description: Metal on resilient material seating.

a. Standards: UL 1091 and FMG approved.
b. Body: Cast or ductile iron.
c. Body Type: [**Wafer**] [**Wafer or flanged**] [**Flanged**].
d. Pressure Rating: 1200 kPa (175 psig).

2.16 PLUG VALVES

A. Plug Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. DeZURIK/Copes-Vulcan; a unit of SPX Corporation.
b. Homestead Valve; a division of Olson Technologies, Inc.
c. Milliken Valve Company.
d. McWane, Inc.; M & H Valve Company Div.
e. Pratt, Henry Company.
f. Val-Matic Valve & Manufacturing Corp.

2. Description: Resilient-seated eccentric.

a. Standard: MSS SP-108.
b. Body: Cast iron.
c. Pressure Rating: 1200-kPa (175-psig) minimum CWP.
d. Seat Material: Suitable for potable-water service.

2.17 [CORPORATION VALVES] [AND] [CURB VALVES]

A. Manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Amcast Industrial Corporation; Lee Brass Co.
b. Ford Meter Box Company, Inc. (The); Pipe Products Div.
c. Jones, James Company.
d. Master Meter, Inc.

e. McDonald, A. Y. Mfg. Co.
f. Mueller Co.; Water Products Div.
g. Red Hed Manufacturing & Supply.

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.

3. [Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.]

C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 75 mm (3 inches) in diameter.

1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.18 UTILITY WATER METERS

A. [Utility water meters will be furnished by utility company.]

B. [Provide Utility water meter.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. AMCO Water Metering Systems.
b. Badger Meter, Inc.
c. Carlon Meter.
d. Hays Fluid Controls; a division of ROMAC Industries Inc.
e. McCrometer.
f. Mueller Co.; Hersey Meters.
g. Neptune Technology Group Inc.
h. Sensus Metering Systems.

C. Type: Provide water meter as required by Utility, as identified in Drawings, or otherwise as selected from one the of following:

1. Displacement-Type Water Meters:

a. Description: With bronze main case.

1) Standard: AWWA C700.
2) Registration: Flow in [liters (gallons)] [cubic meters (cubic feet)].

2. Turbine-Type Water Meters:

a. Description:

1) Standard: AWWA C701.
2) Registration: Flow in [liters (gallons)] [cubic meters (cubic feet)].

3. Compound-Type Water Meters:

a. Description:

1) Standard: AWWA C702.
2) Registration: Flow in [liters (gallons)] [cubic meters (cubic feet)].]]

4. Detector-Type Water Meters:

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Badger Meter, Inc.
2) Mueller Co.; Hersey Meters.
3) Neptune Technology Group Inc.
4) Sensus Metering System.

b. Description:

1) Main line, proportional meter with second meter on bypass. Register flow in [liters (gallons)] [cubic meters (cubic feet)].

a) Standards: AWWA C703, UL listed, and FMG approved.
b) Pressure Rating: 1000 kPa (150 psig).
c) Bypass Meter: [AWWA C701, turbine] [AWWA C702, compound]-type, bronze case.
d) Size: At least one-half nominal size of main-line meter.

2) Main line, turbine meter with strainer and second meter on bypass. Register flow in [liters (gallons)] [cubic meters (cubic feet)].

a) Standards: AWWA C703, UL listed, and FMG approved.
b) Pressure Rating: 1200 kPa (175 psig).
c) Bypass Meter: AWWA C701, turbine-type, bronze case.

d) Size: At least DN 50 (NPS 2).]

D. [Remote Registration System:

1. [Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

a. Standard: AWWA C706.
b. Registration: Flow in [liters (gallons)] [cubic meters (cubic feet)].]

2. [Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

a. Standard: AWWA C707.
b. Registration: Flow in [liters (gallons)] [cubic meters (cubic feet)].
c. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
d. Visible Display Units: Comply with utility company requirements for type and quantity.]

2.19 PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Available Manufacturers:

a. Cash Acme; a division of The Reliance Worldwide Corporation.
b. Conbraco Industries, Inc.
c. Honeywell Water Controls.
d. Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial pressure of 1000 kPa (150 psig).
4. Size: <**Insert DN (NPS)**>.
5. Design Flow Rate: <**Insert L/s (gpm)**>.
6. Design Inlet Pressure: <**Insert kPa (psig)**>.
7. Design Outlet Pressure Setting: <**Insert kPa (psig)**>.
8. Body: Bronze [**with chrome-plated finish**] for DN 50 (NPS 2) and smaller; cast iron[**with interior lining complying with AWWA C550 or that is FDA approved**] for DN 65 and DN 80 (NPS 2-1/2 and NPS 3).
9. Valves for Booster Heater Water Supply: Include integral bypass.
10. End Connections: Threaded for DN 50 (NPS 2) and smaller; flanged for DN 65 and DN 80 (NPS 2-1/2 and NPS 3).

B. Water Control Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.

   a. CLA-VAL Automatic Control Valves.
   b. Flomatic Corporation.
   c. OCV Control Valves.
   d. Watts Regulator Co.; Ames Fluid Control Systems.
   e. Watts Regulator Co.; Watts ACV Division.
   f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.

   a. Pressure Rating: Initial pressure of 1000 kPa (150 psig) minimum.
   b. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

      1) Size: <**Insert DN (NPS)**>.
      2) Pattern: [**Angle**] [**Globe**]-valve design.
      3) Trim: Stainless steel.

   c. Design Flow Rate: <**Insert L/s (gpm)**>.
   d. Design Inlet Pressure: <**Insert kPa (psig)**>.
   e. Design Outlet Pressure Setting: <**Insert kPa (psig)**>.
   f. End Connections: Threaded for DN 50 (NPS 2) and smaller; [**flanged**] <**Insert type**> for DN 65 (NPS 2-1/2) and larger.

2.20 RELIEF VALVES

A. Air-Release Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Crispin-Multiplex Manufacturing Co.
   b. GA Industries, Inc.
   c. Val-Matic Valve & Manufacturing Corp.

2. Description: Hydromechanical device to automatically release accumulated air.

   a. Standard: AWWA C512.
   b. Pressure Rating: [**2000 kPa (300 psig)**] <**Insert pressure**>.
   c. Body Material: [**Cast iron**] <**Insert material**>.
   d. Trim Material: Stainless steel [**, brass, or bronze**].
   e. Water Inlet Size: <**Insert DN (NPS)**>.

f. Air Outlet Size: <**Insert DN (NPS)** >.
g. Orifice Size: <**Insert mm (inch)** >.
h. Design Air-Release Capacity: <**Insert L/s (cfm)**> at <**Insert kPa (psig)**> pipeline pressure.

B. Air/Vacuum Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crispin-Multiplex Manufacturing Co.
b. GA Industries, Inc.
c. Val-Matic Valve & Manufacturing Corp.

2. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.

a. Standard: AWWA C512.
b. Pressure Rating: [**2000 kPa (300 psig)**] <**Insert pressure**>.
c. Body Material: [**Cast iron**] <**Insert material**>.
d. Trim Material: Stainless steel [**, brass, or bronze**].
e. Inlet and Outlet Size: <**Insert DN (NPS)**>.
f. Orifice Size: <**Insert mm (inch)**>.
g. Design Air Capacity: <**Insert L/s (cfm)**> at <**Insert kPa (psig)**> differential pressure.

C. Combination Air Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crispin-Multiplex Manufacturing Co.
b. GA Industries, Inc.
c. Val-Matic Valve & Manufacturing Corp

2. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.

a. Standard: AWWA C512.
b. Pressure Rating: [**2000 kPa (300 psig)**] <**Insert pressure**>.
c. Body Material: [**Cast iron**] <**Insert material**>.
d. Trim Material: Stainless steel [**, brass, or bronze**].
e. Inlet and Outlet Size: <**Insert DN (NPS)**>.
f. Orifice Size: <**Insert mm (inch)**>.
g. Design Air Capacity: <**Insert L/s (cfm)**> at <**Insert kPa (psig)**> differential pressure.

2.21 VACUUM BREAKERS

A. Pressure Vacuum Breaker Assembly:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ames Fire & Waterworks; a division of Watts Regulator Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Toro Co. (The); Irrigation Division.
   f. Watts Water Technologies, Inc.
   g. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [**35 kPa (5 psig)**] <**Insert pressure**> maximum, through middle 1/3 of flow range.
5. Size: <**Insert DN (NPS)**>.
6. Design Flow Rate: <**Insert L/s (gpm)**>.
7. Selected Unit Flow Range Limits: <**Insert L/s (gpm)**>.
8. Pressure Loss at Design Flow Rate: <**Insert kPa (psig)**>.
9. Accessories: Ball valves on inlet and outlet.

2.22 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ames Fire & Waterworks; a division of Watts Regulator Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Wilkins Water Control Products Div

2. Standard: [**ASSE 1013**] [**or**] [**AWWA C511**].
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [**80 kPa (12 psig)**] <**Insert pressure**> maximum, through middle 1/3 of flow range.
5. Size: <**Insert DN (NPS)** >.
6. Design Flow Rate: <**Insert L/s (gpm)**>.
7. Selected Unit Flow Range Limits: <**Insert L/s (gpm)**>.

8. Pressure Loss at Design Flow Rate: <**Insert kPa (psig)**> for DN 50 (NPS 2) and smaller; <**Insert kPa (psig)**> for DN 65 (NPS 2-1/2) and larger.
9. Body: Bronze for DN 50 (NPS 2) and smaller; [**cast iron with interior lining complying with AWWA C550 or that is FDA approved**] [**steel with interior lining complying with AWWA C550 or that is FDA approved**] [**stainless steel**] for DN 65 (NPS 2-1/2) and larger.
10. End Connections: Threaded for DN 50 (NPS 2) and smaller; [**flanged**] <**Insert type**> for DN 65 (NPS 2-1/2) and larger.
11. Configuration: Designed for [**horizontal, straight through**] [**vertical inlet, horizontal center section, and vertical outlet**] [**vertical**] <**Insert configuration**> flow.
12. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of DN 50 (NPS 2) and smaller; OS&Y gate type with flanged ends on inlet and outlet of DN 65 (NPS 2-1/2) and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Ames Fire & Waterworks; a division of Watts Regulator Co.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.
    d. Flomatic Corporation.
    e. Watts Water Technologies, Inc.
    f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

2. Standard: [**ASSE 1015**] [**or**] [**AWWA C510**].
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: [**35 kPa (5 psig)**] <**Insert pressure**> maximum, through middle 1/3 of flow range.
5. Size: <**Insert DN (NPS)**>.
6. Design Flow Rate: <**Insert L/s (gpm)**>.
7. Selected Unit Flow Range Limits: <**Insert L/s (gpm)**>.
8. Pressure Loss at Design Flow Rate: <**Insert kPa (psig)**> for DN 50 (NPS 2) and smaller; <**Insert kPa (psig)**> for DN 65 (NPS 2-1/2) and larger.
9. Body: Bronze for DN 50 (NPS 2) and smaller; [**cast iron with interior lining complying with AWWA C550 or that is FDA approved**] [**steel with interior lining complying with AWWA C550 or that is FDA approved**] [**stainless steel**] for DN 65 (NPS 2-1/2) and larger.
10. End Connections: Threaded for DN 50 (NPS 2) and smaller; [**flanged**] <**Insert type**> for DN 65 (NPS 2-1/2) and larger.
11. Configuration: Designed for [**horizontal, straight through**] <**Insert configuration**> flow.

12. Accessories: Ball valves with threaded ends on inlet and outlet of DN 50 (NPS 2) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of DN 65 (NPS 2-1/2) and larger.

C. Double-Check, Detector-Assembly Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ames Fire & Waterworks; a division of Watts Regulator Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Wilkins Water Control Products Div.

2. Standards: ASSE 1048 and UL listed or FMG approved.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: [**35 kPa (5 psig)**] <**Insert pressure**> maximum, through middle 1/3 of flow range.
5. Size: <**Insert DN (NPS)**>.
6. Design Flow Rate: <**Insert L/s (gpm)**>.
7. Selected Unit Flow Range Limits: <**Insert L/s (gpm)**>.
8. Pressure Loss at Design Flow Rate: <**Insert kPa (5 psig)**>.
9. Body: [**Cast iron with interior lining complying with AWWA C550 or that is FDA approved**] [**Steel with interior lining complying with AWWA C550 or that is FDA approved**] [**Stainless steel**].
10. End Connections: Flanged.
11. Configuration: Designed for [**horizontal, straight through**] [**vertical inlet, horizontal center section, and vertical outlet**] [**vertical**] <**Insert configuration**> flow.
12. Accessories:

    a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
    b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. Backflow Preventer Test Kits:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   c. Flomatic Corporation.
   d. Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; Wilkins Water Control Products Div;

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.23 WATER METER BOXES

A. Description: As indicated on drawings, or otherwise as selected from below as permitted by Local Authorities Having Jurisdiction.

1. Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.
2. Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
3. Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 7000 kg minimum over 250 by 250 mm (15,000 lb minimum over 10 by 10 inches) square. This type is not permitted for use in roadways, but is permitted in walks and unpaved areas away from traffic.

2.24 [CONCRETE VAULTS

A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C857 and made according to ASTM C858, and in accordance with the OBO Zoning Code and local Authorities Having Jurisdiction.

1. Ladder: Fiber-reinforced plastic (FRP) or cast; at 300 to 400 mm intervals.
2. Manhole:

a. [ASTM A48/A48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.

1) Dimension: 900-mm (36-inch) minimum diameter, unless otherwise indicated.]

b. [ASTM A536, Grade 60-40-18, ductile-iron traffic frame and cover.

1) Dimension: 900-mm (36-inch) minimum diameter, unless otherwise indicated.]

3. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.]

2.25 PROTECTIVE ENCLOSURES

A. Freeze-Protection Enclosures:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aqua Shield.
    b. BF Products, Inc.
    c. DekoRRa Products.
    d. Dunco Manufacturing, Inc.
    e. G&C Enclosures.
    f. Hot Box, Inc.
    g. HydroCowl, Inc.
    h. Watts Water Technologies, Inc.

2. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 4 deg C (40 deg F) when external temperatures reach as low as minus 36 deg C (minus 34 deg F).

    a. Standard: ASSE 1060.
    b. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.

        1) Housing: Reinforced[**-aluminum**] [**or**] [**-fiberglass**] <**Insert housing**> construction.

            a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
            b) Drain opening for units with drain connection.
            c) Access doors with locking devices.
            d) Insulation inside housing.
            e) Anchoring devices for attaching housing to concrete base.

        2) Electric heating cable or heater with self-limiting temperature control.

B. Weather-Resistant Enclosures:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aqua Shield.
    b. BF Products, Inc.
    c. DekoRRa Products.
    d. Dunco Manufacturing, Inc.
    e. G&C Enclosures.
    f. Hot Box, Inc.
    g. HydroCowl, Inc.
    h. Watts Water Technologies, Inc.

2. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.

   a. Standard: ASSE 1060.
   b. Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.

      1) Housing: Reinforced[**-aluminum**] [**or**] [**-fiberglass**] <**Insert housing**> construction.

         a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
         b) Drain opening for units with drain connection.
         c) Access doors with locking devices.
         d) Anchoring devices for attaching housing to concrete base.

C. Expanded-Metal Enclosures:

1. Available Manufacturers:

   a. Backflow Prevention Device InnClosures, Inc.
   b. BF Products, Inc.
   c. Cross Brothers, Inc.
   d. Le Meur Welding & Manufacturing Co.

2. Description: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.

   a. Material: ASTM F1267, expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
   b. Type: Type[**I, expanded**] [**II, expanded and flattened**].
   c. Class: Class[**1, uncoated carbon steel**] [**2, hot-dip, zinc-coated carbon steel**] [**3, corrosion-resisting steel**].

   d. Finish: Manufacturer's enamel paint.
   e. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
   f. Locking device.
   g. Lugs or devices for securing enclosure to base.

D. Enclosure Bases:

1. Description: [**100-mm- (4-inch-)**] [**150-mm- (6-inch-)**] minimum thickness precast concrete, of dimensions required to extend at least 150 mm (6 inches) beyond edges of enclosure housings. Include openings for piping.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section on "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping [**DN 20 to DN 80 (NPS 3/4 to NPS 3)**] <**Insert pipe size range**> must be any of the following:

1. Soft copper tube, [**ASTM B88M, Type A**] [**ASTM B88M, Type B**]; [**wrought-copper, solder-joint fittings; and brazed**] [**copper, pressure-seal fittings; and pressure-sealed**] joints.
2. PE, ASTM pipe; [**insert fittings for PE pipe; and clamped**] [**molded PE fittings; and heat-fusion**] joints.
3. PVC, Schedule [**40 pipe; PVC, Schedule 40**] [**80 pipe; PVC, Schedule 80**] socket fittings; and solvent-cemented joints. Solvent cemented joints must be limited to piping size 50 mm or smaller.

F. Underground water-service piping [**DN 100 to DN 200 (NPS 4 to NPS 8)**] <**Insert pipe size range**> must be any of the following:

1. Ductile-iron, [**push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed**] [**mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical**] [**grooved-end pipe; ductile-iron-pipe appurtenances; and grooved**] joints.
2. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
3. PVC, Schedule [**40 pipe; PVC, Schedule 40**] [**80 pipe; PVC, Schedule 80**] socket fittings; and solvent-cemented joints.
4. DN 100 and DN 150 (NPS 4 and NPS 6): DN 150 (NPS 6) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 [**fabricated**] [**or**] [**molded**] fittings; and gasketed joints.
5. DN 200 (NPS 8): PVC, AWWA Class 200 pipe; [**PVC, AWWA Class 200 fabricated**] [**push-on-joint, ductile-iron**] [**mechanical-joint, ductile-iron**] fittings; and gasketed joints.

G. Water Meter Box Water-Service Piping [**DN 20 to DN 50 (NPS 3/4 to NPS 2)**] <**Insert pipe size range**> must be same as underground water-service piping.

H. [Underground Combined Water-Service and Fire-Service-Main Piping [NPS 6 to NPS 12 (DN 150 to DN 300)] <Insert pipe size range> must be of the following:

1. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.]

I. [Aboveground [and Vault] Combined Water Service and Fire-Service-Main Piping [DN 150 to DN 300 (NPS 6 to NPS 12)] <Insert pipe size range> must be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.]

J. Underground Reclaimed Water Service Piping must be PVC, Purple Schedule **[40 pipe; PVC, Schedule 40] [80 pipe; PVC, Schedule 80]** socket fittings; and solvent-cemented joints. PVC pipe for recycled water system applications must be purple. Fittings and pipe appurtenances installed with PVC mains for recycled water must be identified with purple-colored coating, purple polyethylene sleeves, and identification labels,

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for DN 80 (NPS 3) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for DN 50 (NPS 2) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Valve Type:

   a. Ball valves must be used for water mains DN 50 (NPS 2) or smaller. Class 150, ferrous alloy.
   b. Gate valves must be used for water mains DN 65 (NPS 2-1/2) or larger. Class 150, ferrous alloy.
   c. Butterfly valves are permitted only for water mains DN 300 (NPS 12) or larger, with approval by Project Director/COR based upon input from OBO/PDCS/DE/CSE civil engineer. Flangeless, 100-kPa (15 psig) CWP rating, ferrous alloy, with EPFM liner.

2. Underground Valves, DN 100 (NPS 4) and Larger, for Indicator Posts: UL/FMG, cast-iron, non-rising-stem gate valves with indicator post.
3. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
4. Relief Valves: Use for water-service piping in vaults and aboveground.

a. Air-Release Valves: To release accumulated air.
b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
c. Combination Air Valves: To release or admit air.

5. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

3.4 [PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Division 33 Section on "Common Work Results for Utilities" for piping-system common requirements.]

3.5 PIPING INSTALLATION

A. Water-Main Connection:

1. [Arrange with utility company for tap of size and in location indicated in water main.]

2. [Tap water main according to requirements of water utility company and of size and in location indicated.]

B. Make connections larger than DN 50 (NPS 2) with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Make connections DN 50 (NPS 2) and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install manifold for multiple taps in water main.
6. Install curb valve in water-service piping with head pointing up and with service box.

D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install PE corrosion-protection encasement according to ASTM A674 or AWWA C105.

E. Install PE pipe according to ASTM D2774 and ASTM F645.

F. Install PVC, AWWA pipe according to ASTM F645 and AWWA M23.

G. Bury piping with depth of cover over top at least [**1000 mm (36 inches)**] <**Insert dimension**>, with top at least [**300 mm (12 inches)**] <**Insert dimension**> below level of maximum frost penetration, and according to the following:

1. [Under Railroad Tracks: With at least [1200 mm (48 inches)] <Insert dimension> cover over top.]

H. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

I. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

J. Mechanical sleeve seals are specified in Division 22 Section on "Sleeves and Sleeve Seals for Plumbing Piping."

K. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

L. See Division 22 Section on "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. [See Division 33 Section on "Common Work Results for Utilities" for basic piping joint construction.]

B. Make pipe joints according to the following:

1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
4. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
5. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D2774 or ASTM D3139 and pipe manufacturer's written instructions.
6. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

a. Dielectric Fittings for [**DN 50 (NPS 2)**] <**Insert pipe size**> and Smaller: Use dielectric [**nipples**] [**unions**].
b. Dielectric Fittings for [**DN 65 to DN 100 (NPS 2-1/2 to NPS 4)**] <**Insert pipe size range**>: Use dielectric [**flanges**] [**flange kits**] [**nipples**].
c. Dielectric Fittings for [**DN 125 (NPS 5)**] <**Insert pipe size**> and Larger: Use dielectric flange kits.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.
7. <**Insert devices**>.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. [**Install full-size valved bypass.**]

H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.9 DETECTOR-CHECK VALVE INSTALLATION

A. Install in vault or aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

3.10 UTILITY METER INSTALLATION

A. Install water meters, piping, and specialties **[according to utility company's written instructions] [as indicated on the Drawings]**.

B. Water Meters: Installation must be in relation to meter type: as indicated on the Drawings and

1. Install displacement or turbine-type water meters, DN 50 (NPS 2) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
2. Install compound or turbine-type water meters, DN 80 (NPS 3) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
3. Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.11 ROUGHING-IN FOR UTILITY WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.12 VACUUM BREAKER ASSEMBLY INSTALLATION

A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.13 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support DN 65 (NPS 2-1/2) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.14 UTILITY METER BOX INSTALLATION

A. Install water meter boxes as indicated on the Drawings, as specified below, and in accordance with Local Authorities Having Jurisdiction.

1. Install in paved areas flush with surface.
2. Install water meter boxes in grass or earth areas with top **[50 mm (2 inches)] <Insert dimension>** above surface.

3.15 [CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C891.]

3.16 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top approximately [**50 mm (2 inches)**] <**Insert measurement**> above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.17 CONNECTIONS

A. [See Division 33 Section on "Common Work Results for Utilities" for piping connections to valves and equipment.]

B. Connect water-distribution piping to **[utility water main] [existing water main] <Insert piping system>**. Use **[tapping sleeve and tapping valve] [service clamp and corporation valve] <Insert method>**.

C. Connect water-distribution piping to interior domestic water piping.

D. Connect waste piping from concrete vault drains to **[sanitary sewerage system. See Division 33 Section on "Site Sanitary Sewers" for connection to sanitary-sewer] [storm-drainage system. See Division 33 Section on "Site Storm Utility Drainage Piping" for connection to storm-sewer]** piping.

E. Ground equipment according to Section 260525 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260518 "Low-Voltage Electrical Power Conductors and Cables."

3.18 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 350-kPa (50-psig) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 kPa (0 psig). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 1.9 L (2 quarts) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.19 IDENTIFICATION

A. Install continuous underground [**detectable**] warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section on "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. **[See Division 33 Section on "Common Work Results for Utilities" for identifying devices.]**

C. Pipe markings for PVC pipe for recycled water system must include designation “RECLAIMED WATER” in addition to standard labels required.

3.20 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by Project Director/COR based upon input from OBO/PDCS/DE/CSE, or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to Project Director/COR, and to local Authorities Having Jurisdiction if they require samples. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331416

333700 – WASTEWATER TREATMENT PLANT

PART 1 - GENERAL

1.1 SUMMARY

A. This Specification Section is based on the following requirements:

1. Secondary Clarification System: Plant design must use the following system type:

a. [Gravity-based system.]
b. [Dissolved Air Floatation (DAF) system.]

1.2 SUBMITTALS

A. Qualifications: Furnish evidence for experience of manufacturer and manufacturer's field representative as required in Article on QUALITY ASSURANCE. Include project references and contact information.

B. Shop Drawings:

1. Site layout in consistent scale, showing size, spacing, and locations of all proposed process units, piping, wiring, and accessory equipment.
2. Layout drawings and sections showing profile views, maximum water surface elevations, and wall heights for process units. Include piping plan and profiles.
3. Detailed equipment drawings for fabricated items.
4. Schematic Diagrams: General diagram showing Process Flow Diagrams (PFDs). Detailed P&ID diagrams showing complete instrumentation, controls, and flow from and out of primary clarifiers **[to on-site reclaimed water storage tank]**. Show sludge digestion management, waste holding tank, and other auxiliary systems in diagram.
5. Control panel layout with graphic representation of P&ID showing status of all equipment with HOA switches, various instruments, and controls indicated in Construction Drawings.
6. Air supply and diffusion equipment layout, including air header layouts.

C. Product Data:

1. Technical literature; clearly identify applicable items including blowers, instruments, flowmeters, MBBR components, secondary clarification components, UV Disinfection, pumps, filtration, and chlorination equipment.
2. Manufacturer cut sheets with published ratings, capacity data, and specific models selected.

D. Design Calculations:

1. List utility requirements and projected monthly consumption rates at full plant capacity.

2. Structural and certified engineering calculations for tanks, structural members, foundations, and pads.
3. Table summarizing power requirements and breaker sizes.

E. Factory quality-control test reports; see Article on SOURCE QUALITY CONTROL.

F. Installation instructions and other pertinent installation data and procedures.

G. Start-up and testing plan in accordance with Article on PLANT START-UP.

H. Field quality-control and start-up reports; see Article on PLANT START-UP.

I. Operation and Maintenance Data, complete with easy-to-follow instructions to facilitate inexperienced personnel in obtaining and maintaining required levels of performance.

1. List of references and contact information for major elements of systems.

J. Warranties: Properly executed warranties from manufacturer as required by these Specifications.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer must have minimum of ten years active experience in design, fabrication, installation, testing, start-up, training, and service of wastewater treatment plants of similar type and size. Firms must have achieved NSF/ANSI 40 certification for their small packaged units.

1. This manufacturer must be licensed by a State in USA, European Union, or equivalent, as approved by the owner.
2. Manufacturer's Field Representative: Minimum of ten years active experience in installation, testing, start-up, training, and service of wastewater treatment plants of similar type and size.

B. Manufacturer Certification: ISO 9001 quality standards.

C. Standards for fabrication and erection of tanks and basins:

1. "AISC Specification for Building"
2. "ACI 318 Building Code Requirements for Reinforced Concrete and Commentary"
3. "ACI 350 Environmental Engineering Concrete Structures"
4. "ASTM- A36 , low carbon plates for tank construction"
5. "ASTM-A48, Grey Iron Casting"

1.4 DELIVERY, STORAGE, AND HANDLING

A. Detach or support main electrical console panels and controls for secondary and tertiary systems prior to shipping.

B. Manufacturer must furnish lifting hooks and include graphic and descriptive procedures for unloading and picking up equipment, and installation, along with safety procedures.

C. Unload tanks and equipment in accordance with manufacturer's instructions.

D. [Deliver DAF system to jobsite complete with dissolved air system, saturators, recycle pumps, drive assembly, local wiring, valves, gauges, controls, anchor bolts and other appurtenances, including all piping and components necessary for complete operating installation.]

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to provide labor and technical assistance, and repair or replace components of system within specified warranty period.

B. Warranty Period:

1. Process Tanks: 15-year warranty, with no limits on pH, TDS or chemicals used in process
2. Warranty that all parts are free from defects in material and workmanship for minimum of two years after substantial completion.

1.6 EXTRA MATERIALS

A. Furnish spare parts, consumables, and sufficient parts and supplies for 12 months of operation and regularly scheduled maintenance.

1. Furnish 10 spare cartridges.
2. Chlorine supplies.

1.7 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date for a period of one calendar year provide system maintenance service based on manufacturer's recommended daily, weekly, monthly, quarterly, semi-annual, and annual maintenance activities. In addition to the initial year of maintenance service, provide a proposal for a renewable option year. The option year proposal must be submitted 60 days prior to the end of the initial maintenance contract period.

B. Maintenance service must be inclusive of controls set-up and programming, troubleshooting, and alarms based on manufacturer's recommendations and the operation and maintenance information, using factory-trained service personnel as required for proper system operation.

C. Maintenance service must include preventive maintenance, repair or replacement of worn or defective components, required supply of chemicals, and inspecting/adjusting as required for proper system operation, as well as other specific service identified under this specification section. Specific maintenance tasks must also align with the manufacturer's recommended

checklists as required in Division 01 Section 017825 "Systems Manual and O&M Data." Provide completed maintenance records inclusive of scheduling to the USG for inclusion in the CMMS.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Provide on-site Wastewater Treatment Plant (WWTP), complete and ready for operation, in accordance with Construction Drawings and these Specifications. Include components and installation necessary to conform to system performance requirements.

1. **[Odor Control: Sludge digester, sludge holding tank, primary settling basin, and equalization basin require venting and odor control.]**
2. Basic MBBR and secondary clarification systems must be factory assembled as package units, including piping and controls, with limited separate components.

2.2 SYSTEM PERFORMANCE

A. Wastewater treatment plants must conform to minimum Class A standards.

B. Provide wastewater treatment plant based upon on-site Moving Bed Bio-Reactor (MBBR) process-based design, wastewater treatment plant must be completed in general conformance with the following:

1. System Reference Standards: “Recommended Standards for Wastewater Facilities,” (referred to as “10-States Standards”) The Wastewater Committee of the Great Lakes – Upper Mississippi River. These Standards are the source for baseline size and design requirements major components of the system unless more stringent requirements are indicated in these specifications.
2. Plant must include backup of critical systems as necessary for continuous and efficient plant operation, monitoring, and control.
3. Treatment Process:

   a. Minimum elements include lift station, primary treatment; aerated equalization basin with equalization flow pumps; aerated MBBR reactors with blowers sized for BOD removal rates and suspension of the media; secondary clarifier; UV disinfection; chlorination as required to provide a minimum of 1 mg/L chlorine residual in reclaimed water; and batch aerated sludge digesters performing in accordance with “10-State Standards” and EPA 503 requirements for Class B sludge.
   b. Vented /aerated liquid waste sludge holding tank sized for minimum of seven days of storage between truck removals of waste sludge.

4. System must be capable of treating raw domestic sewage to effluent water quality conditions identified in Table 3.4, “Basis of Design” for EFFLUENT WATER QUALITY System design must allow for Infiltration & Inflow (I&I) flows based on the following criteria: three gallons per hour for inflow contribution into each manhole, and infiltration

rate of 100 gallons per day, per inch diameter, per mile of pipe if ground water is at or below midpoint of sewer pipes

5. Equalization Basin: Volume of no less than 35 percent of the average daily flow volume and meet the minimum conditions listed in Table 3.4, "Basis of Design" for EQUALIZATION BASIN.
6. Influent Water Quality: Generally compatible with Domestic wastewater; see Table 3.4, "Basis of Design Table" for INFLUENT WATER QUALITY.
7. Effluent Water Quality: Conform to criteria as identified in Table 3.4, "Basis of Design" EFFLUENT WATER QUALITY.
8. Secondary clarifier must conform to Table 3.4, "Basis of Design" for DAF or for GRAVITY, as applicable to WWTP system design.
9. Tertiary filtration systems must ensure that effluent conforms to Table 3.4, "Basis of Design" under EFFLUENT WATER QUALITY for required Total Suspended Solids (TSS) limits.

C. Corrosion Protection:

1. Corrosion protection must conform to OBO Electrical Code Chapter 1 and OBO Building Code Appendix W.
2. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
3. All submerged metal piping must be stainless steel.

2.3 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, those listed below. Not all components may be available from one single manufacturer; coordinated mixing of components from multiple manufacturers is acceptable for providing complete packages, as long as the total plant is integrated under one company complying with the qualification requirements in the Article on QUALITY ASSURANCE.

1. Headworks International
2. World Water Works
3. WSI International
4. Pollution Control Systems, (PSI) Inc.
5. EEC Global Operations LLC- Veolia
6. Evoqua Water Technologies
7. Aeromix
8. JET (subject to approvals of concrete tanks)

2.4 TANKS

A. System manufacturers must identify actual dimensions on Shop Drawings consistent with system description and performance requirements of this Section.

B. Tanks must be designed for worst conditions, including the following:

1. Allow one process train to be dewatered while one train is full of liquid and operational.
2. All trains may be full of liquid and operational.
3. Any one basin by itself or combination may be empty or full while being operational.

C. Anodes: Provide sacrificial magnesium anodes for buried tanks.

D. Primary Clarifier Basin, Equalization Basin, and Aerobic Sludge Digester Tanks: Cast-in-place or precast concrete, designed for complete or partial burial. Internal tank surfaces must be epoxy coated with two-coat system; minimum dry thickness of 2 mm (80 mils).

E. MBBR, Secondary Clarifier, and Other Process Tanks: Components that are exposed to elements and in unprotected environment must meet one of the following:

1. Steel Tanks:

a. Fabricate tanks of minimum 6.35 mm structural grade steel plate conforming to ASTM A-36.
b. Join steel sections by arc welding with fillets of adequate section for joint involved. Connections must conform to American Welding Society (AWS) D1.1 and must develop full strength of member.
c. Walls must be continuous and watertight and must be supported by structural reinforcing members.
d. Fabrication and installation must conform to “AISC Specification for Buildings.”
e. Fabricate reinforcing members with 1.83 meter maximum spacing, and with H-frame reinforcing on end walls and partition walls.
f. Tank interior and exterior surfaces must be prepared and coated to obtain smooth, clean, dry, and corrosion resistant surface. Remove rust, dust, and mill scale, and other deleterious matter from interior surfaces by means of near white sandblast, SSPC-SP10. Sandblast external surfaces in accordance with SSPC-SP6. Paint interior and exterior vessel surfaces with coats of coal tar epoxy; Basis of Design is Tnemec series 46H-413, 0.4 mm (16 mils) minimum total dry film thickness.

2. Stainless Steel Tanks:

a. Fabricate with structural grade stainless steel plates, minimum 10 gauge.
b. Join stainless steel sections by arc welding with fillets of adequate section inside and out for joints involved. Connection must conform to AWS D1.1 and must develop full strength of member.
c. Walls must be continuous and watertight and must be supported by structural reinforcing members.
d. Fabrication and erection must include exterior/interior beams and bars for anticipated loads and must conform to applicable requirements of "AISC Specification for Building."

3. Non-Metallic Tanks:

a. Tank must be fabricated from high-impact stress-relieved UV-Stabilized Euro-Grey Copolymer Polypropylene, PVC, or equivalent material accepted by Project Director/COR based upon input from OBO/PDCS/DE/CSE civil engineer.
b. Tank shell must be minimum 25 millimeter thick.
c. Butt welds must have 100 percent penetration using automated butt fusion equipment. Structural welding must be flat clean smooth extrusion welds; use nitrogen to minimize oxidation.

4. [Reinforced Concrete Tank: See Section 033000 "Cast-in-Place Concrete" for general requirements for concrete.

a. Epoxy coat with two-coat system (minimum dry thickness of 2 mm (80 mils).]

2.5 INLET BAR SCREEN, PRIMARY CLARIFIER, AND EQUALIZATION TANK

A. Inlet Bar Screen: Provide screen at influent port to remove unusually large solids from incoming raw sewage.

1. Fabricate screen from 15DN bars spaced 25 mm apart and arrange as indicated on Drawings.
2. Slope bars 30 to 60 degrees to permit easy cleaning of accumulating debris.
3. Furnish drying deck for drying debris.
4. Locate bar screen at headworks in incoming manhole upstream of flow measuring v-notch weir plate.
5. Size bar screen in accordance with conditions identified in Table 3.4, "Basis of Design" for EFFLUENT WATER QUALITY.

B. Primary Clarifier Chamber: Provide chamber to work in conjunction with equalization chamber. Size clarifier chamber in accordance with the requirements for Primary Clarifier in Table 3.4, "Basis of Design" for PRIMARY CLARIFIER

C. Equalization Chamber: Provide chamber in accordance with conditions identified in Table 3.4, "Basis of Design" for EQUALIZATION BASIN and the following:

1. Fabricate flow equalization chamber to allow for constant flow through plant by equalizing flow surges that may be incurred during peak flow
2. Provide duplex set of equalization pumps within chamber. Provide emergency overflow from MBBR aeration chamber to equalization tank. Provide liquid level sensors to regulate pumps, and place controls in plant control panel. Provide dual rails using Type 304 L stainless steel. Fabricate to facilitate pump replacement and maintenance without entry into tank.

2.6 MOVING BED BIO-REACTOR (MMBR) FABRICATION

A. MBBR system must be two-stage (series) system. Fabricate complete system with media, aeration system, media retention screens, piping, and other appurtenances and accessories as identified Drawings, or otherwise necessary for properly operating MBBR installation.

B. Tanks for this system must be fabricated in accordance with Article on TANKS.

C. Provide aeration chamber in accordance with Table 3.4, "Basis of Design" on MBBR PROCESS **[This process must work in conjunction with DAF- Based clarification process as described in Table 3.4, "Basis of Design" for DAF.]** Aeration process must conform to the following:

1. Provide biofilm carrier elements of material, size and geometry that will enable system to reliably conform to conditions and requirements identified in Table 3.4, "Basis of Design" for EFFLUENT WATER QUALITY.
2. Aeration chamber must be of sufficient capacity to provide required hydraulic retention time (HRT) based on the equalized average daily flow. Shape vessel on each side to prevent sludge accumulation and to allow carrier elements to freely move within the reactor.
3. Entire aeration system must provide adequate/full floor coverage to produce uniform distribution of air to each lateral, and to allow for 50 percent of design airflow without loss of equal distribution of air to each lateral. Each aeration grid must be comprised of central manifold of 304L SS schedule 10 thickness equipped with diffuser laterals of 304L SS Schedule 5 thickness.
4. To ensure maximum retention and to eliminate short circuiting of raw sewage particles, fabricate aeration chamber with centralized air diffusers placed longitudinally along one side of chamber; this enhances spiral rotation of chamber contents (in conjunction with flow control baffles). Ensure sufficient velocity of rotation to scour bottom and prevent sludge filleting and prevent escape to surface of minuscule air diffusion bubbles; this should facilitate entrapment of bubbles to provide maximum oxygenation efficiency.
5. Install air distribution manifold longitudinally on one side of tank, with connection to diffuser drop assemblies.
6. Equip each diffuser drop assembly with air regulating and shutoff valve, disconnecting union, and diffuser bar with non-clog air diffuser nozzles. Ensure sufficient air velocity for self-cleaning. Ensure oxygen transfer capacity of each diffuser so that adequate supply of oxygen is maintained in aeration chamber to conform to treatment requirements in Table 3.4, "Basis of Design" under EFFLUENT WATER QUALITY.
7. Install retention screens to retain carrier elements within each reactor. Maximum allowable headloss through sieve assemblies is 50 mm at peak hydraulic flow conditions. System supplier must furnish and install the required sieve assemblies.
8. System supplier must furnish and install all necessary supports, fasteners, and anchor bolts for aeration manifold and sieve assemblies. Submerged supports and connection hardware must be fabricated of stainless steel, Type 304 L.
9. Air supply blowers must have Variable Frequency Drives (VFDs). Rate of air supply must be automatically adjusted based on the continuous online Dissolved Oxygen (DO) monitor.

2.7 AERATED SLUDGE DIGESTER

A. Fabricate aerated sludge digester as integral part of wastewater treatment system out of 6.35 mm steel or stainless steel plate. Chamber must have same protective coating and structural requirements as specified for treatment plant.

B. Chamber must be of aerated type. Supply diffused air by plant blower system supplying a minimum of 0.5 L/(m^3.sec) of tank volume (or 30 cfm per 1000 ft^3 of digester volume). Locate diffusers parallel to and near bottom of tank. Factory install all piping and valves within chamber.

C. Provide sludge withdrawal piping and valves.

D. Provide adjustable submersible decant pump to transfer supernatant from sludge digester to primary clarifier.

E. Dry Well Fabrication: Fabricate dry well with hatches, vents, and ladders for safe access in accordance with the OBO Zoning Code.

2.8 SECONDARY CLARIFIER SYSTEM

A. Tanks for these systems must be fabricated in accordance with Article on TANKS.

1. [Gravity-Based Clarifier: Refer to parameters in Table 3.4, "Basis of Design" for SECONDARY CLARIFIER: GRAVITY TYPE.]

2. [Dissolved Air Flotation (DAF):

a. Refer to parameters in Table 3.4, "Basis of Design" for SECONDARY CLARIFIER: DAF TYPE.

b. Manufacturer: All components for DAF process must be provided by single manufacturer with minimum five years experience fabricating equipment using this process.

c. DAF system must recirculate effluent and dissolve atmospheric air into water to provide micro-bubble size distribution as necessary for proper system functioning.

d. Separated top solids must be removed by chain-and-flight system fabricated of polymeric chain and fiberglass or polypropylene flights.

e. DAF process must utilize optimum flow path to optimize separation efficiencies.

f. Provide pressure relief valve on discharge side of regenerative pump to ensure pump is not dead-ended.]

2.9 AIR SUPPLY BLOWER UNITS

A. Provide minimum of two blowers for supplying air requirement of equalization tank; one must be fully redundant. Provide blowers for secondary MBBR systems as indicated on Drawings.

B. Blower must be driven by motor using close coupled drive assembly.

C. Provide each blower and motor with weatherproof enclosure. Design hood for easy access to service and provide latching handle.

D. Fabricate adjustable motor mount such that "V" belt drive connection between blower and motor can be easily adjusted.

E. Fit blowers with dry type wire mesh filter-silencer at air intake. Fit blower discharge with check valve and flexible rubber discharge coupling.

F. Mount blower motor enclosures on vibration dampeners to reduce vibration and noise. Noise levels must not exceed 79 dBA at one meter from equipment. Mount pressure relief valve and pressure gauge in air manifold for purposes of determining blower performance and diffuser condition.

2.10 PUMPS

A. Pump Assemblies: Cast iron, submersible, centrifugal, non-clogging type with stainless steel shafts and stainless steel rail.

1. Pumps must be capable of handling raw sewage and passing 35 mm solid.
2. Pumps must be capable of continuous operation submerged or in dry condition without adverse effects due to heat generation.

B. Motor Housing and Volute: Cast iron in accordance with ASTM A-48, with appropriate coatings to protect pump from corrosive properties of material being pumped.

C. Provide O-ring sealing between motor unit and volute to prevent external leakage.

D. Pump Motor Cable: Heavy-duty type suitable for submersible pump applications and sized in accordance with NEC and IEEE specifications for pump motors. Provide cable supports of wire braid sleeve type with Appendix tails for connection beneath access hatch frame.

E. Fabricate to automatically and firmly connect to discharge connection, guided by two stainless steel guide bars extending from top of tank to bottom. There must be no need for personnel to enter tank for pump removal.

2.11 CARTRIDGE FILTER

A. Provide 316 cartridge filters with Stainless Steel or non-metallic corrosion resistant housing.

B. Provide 1 micron melt blown filter cartridges.

C. Provide inlet and outlet pressure gauges and isolation valves on each filter housing.

2.12 UV DISINFECTION

A. System Type: Furnish and install a complete low pressure high output or medium pressure lamp UV disinfection system.

B. Referenced Standards: U.S. EPA “Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule” (November 2006).

C. System Capacity: UV system must be able to deliver minimum dose of 40 mi/cm^2.

D. Maximum allowable head loss across UV reactor at peak design flow must be 30 mm.

E. System Description: System must include, but not be limited to disinfection chamber, UV lamps, system power, and system control equipment.

1. System must consist, at a minimum, of two closed conduit UV vessels (one duty and one standby), each rated for design flow. Provide inlet/outlet isolation valves and reducers with each vessel if necessary.
2. Each closed conduit vessel reactor must have UV chamber of type 316L stainless steel.
3. Equip chamber with drain valve and manual air release valve.
4. UV system must control power output to lamps between 50 and 100 percent, with adjustments at 1 percent increments based upon flow.

F. Housing: House electronics and controls in panel enclosure in accordance with Article on ELECTRICAL AND CONTROL REQUIREMENTS. Mount on stand near UV units.

G. Interconnecting cables between UV reactor and control cabinets must be furnished as part of UV system.

2.13 CHLORINATION

A. Chlorination equipment must utilize liquid hypochlorite. Chlorinator must have capacity to provide minimum chlorine residual concentration of 1 mg/L.

1. Solid chlorine tablets may be used instead where regionally availability. For use of chlorine tablets, Contractor must submit documentation demonstrating acceptable availability to Project Director/COR for approval.

2.14 [ODOR CONTROL

A. When required, the odor control system must meet the following criteria:

1. Vessel Design and Airflow Configuration: Radial or up-flow design type.
2. Media: Activated Carbon, synthetic Biofilter, or combination of Activated Carbon and Activated Alumina. Media must be designed specifically for hydrogen sulfide removal.
3. Typical system design is single combined odor control system with vent pipes on suction of blower as indicated on Drawings. If project-specific system design shown on Construction Drawings places these tanks to be far away, then individual smaller odor control systems must be provided.
4. Odor control system materials, including associated hardware, must be selected for capability to resist attack from hydrogen sulfide or other compounds typically found in domestic wastewater.

5. **The fan must be a centrifugal industrial fiberglass reinforced plastic (FRP) fan. All parts of the fan that are exposed to the airstream must be encapsulated in FRP with graphite impregnation to ensure corrosion resistance and spark proof operation.**
6. **Fans: Equip with Flanged outlet / inlet, PVC coupling drain, Teflon shaft seals, Safety belt guard, and V-belt drive.]**

2.15 ELECTRICAL AND CONTROL REQUIREMENTS

A. Electrical Requirements:

1. Provide NEMA 4X weatherproof enclosure for all electrical/control panels. Mount as indicated on Drawings. Exterior mounting hardware must be stainless steel.
2. Wiring:

   a. Analog Signal Wiring: Minimum 16 gauge twisted pairs with foil shield and drain wire, with 300-volt, 90 degrees C insulation.
   b. Drain Wiring: Grounded at one end only.
   c. Other Control Wiring: Stranded copper. Control wiring must be 2.5 mm^2 (#14 AWG), 600 volt.

3. Fiber Optic Cable: 6-strand 62.5/125-micron multi-mode, gel-filled suitable for outdoor service regardless of location installation. Provide patch panel in each control panel for terminating fiber optic cable.
4. Electrical Controls: Magnetic starters, timers, and switches necessary to automatically control electrical devices, motors, and blowers. Protect electrical equipment and circuitry with properly sized circuit breakers or fuses. Design duplex or standby equipment so that they may be operated by devices within control system. Refer to Division 26 Sections for general electrical requirements.
5. Provide all wire and conduit required between control panel and electrical power service. All wiring and conduits associated with packaged systems must be fabricated by system manufacturer at factory.
6. Motors:

   a. Totally Enclosed Fan Cooled) (TEFC), heavy duty, premium efficiency with 1.15 service factor, and rated for Class 1 Division 2 locations.
   b. [Conform to requirements of Division 22 Section "Common Motor Requirements for Plumbing Equipment."]

B. Main Control Panels and Instrumentation:

1. Process controls and instruments indicated on Drawings are minimum required. Provide additional devices as required by system manufacturers for operation and control of such systems.
2. Instruments must be loop powered from Main Control Panel (MCP) unless local power is provided to instruments from local panels.
3. Ethernet Cables (ET): CAT-6 Ethernet/IP cables.

4. Mount indicators adjacent to instruments, making certain they are readable from walkways and platforms. If instrument is below grade, mount indicator on rails or adjacent walls so they are located between 1.0-1.5 meters above floor.
5. Provide analyzers and instruments suspended in tanks with perforated PVC pipe supported to tank as stilling well.
6. Instruments, analyzers, floats, flow meters, and level sensors must be corrosion resistant, and be compatible with domestic wastewater.

2.16 SERVICE WALKWAYS AND STAIRWAYS

A. Provide service walkways and stairways for top of tanks and tank openings to service plant equipment. Grating panels must have maximum yield strength of 250 MPa. Support each panel to have uniform load carrying capacity of 390 kg per square meters.

B. Provide hand-railing system at tank openings and perimeter of tanks. Railing must consist of two rails supported by posts on spans not to exceed 2.4 m on center, with top rail 1.07m from walkway surface and middle rail to be 0.45 m below top rail. Railing must be secured with four-bolt stanchion connection to tank surface at each post.

C. Grating, walkways and railing must be Anodized Aluminum, Fiberglass Reinforced Plastic or Epoxy coated steel.

D. Base toe-plates of the same material as the handrail must be provided to prevent objects from falling into process tanks.

2.17 LABORATORY TESTING EQUIPMENT

A. Furnish laboratory equipment identified in Table 2.1, as indicated in Drawings, and as otherwise identified in this Section.

B. Furnish portable laboratory test kit to facilitate gathering data for proper operation of wastewater treatment system for testing identified in "The Standard Methods for the Examination of Water and Wastewater," a joint publication from American Public Health Association, American Water Works Association, and Water Environment Federation."

1. Include equipment such as bottles, graduated cylinders, and Imhoff settling flask. Furnish renewable standard solutions in easy-to-use, distinctly marked containers in sufficient quantity for six months of normal operation.
2. Furnish benchtop testing equipment identified in Table 2.1:

TABLE 2.1
BENCHTOP TESTING EQUIPMENT

EQUIPMENT	PARAMETERS	RANGE/ FEATURES
Turbidimeter	Turbidity	0-1000 NTU

TABLE 2.1
BENCHTOP TESTING EQUIPMENT

EQUIPMENT	PARAMETERS	RANGE/ FEATURES
Colorimeter	Metals, COD, Color, Hardness, TKN, Chloride	Varies
Dissolved Oxygen Meter	DO	0-60 mg/L
Multi-Parameter	Ph, ORP, Conductivity, TDS, Temperature	Field Hand Held
Jar Tester	Jar Test	4 Paddle, Variable Speed
Suspended Solids	TSS, Turbidity, Sludge Level	0-100 mg/L Hand Held
Sludge Settleability Test	Rate of Sludge Settlement	mL/min
BOD Incubator	BOD	Control Humidity and Temp.

2.18 SOURCE QUALITY CONTROL

A. Factory test MBBR unit as complete assembly prior to delivery to site.

B. [Factory test DAF unit as complete assembly prior to delivery to site.]

C. Manufacturer must test wiring and conduits associated with packaged systems at factory prior to delivery to site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and install foundation pads as indicated on approved shop drawings.

1. Set chamber for aerated sludge digester on same concrete foundation pad as wastewater treatment plant, and at location indicated on Drawings.

B. Install tanks, basins, and accessories in accordance with manufacturer's recommendations, as indicated on approved shop drawings.

1. Ensure all tank walls are continuous and watertight.
2. Bury tank anodes, and securely connect to tank walls with heavy copper wire. Install minimum of one 8 Kg anode for every 3 meters of tank perimeter length.

C. Mount and align air blower supply unit on common base frame. Reinforce base structure support blower and motor unit.

D. Field route sludge withdrawal piping and valves to sludge disposal point as indicated on Drawings.

E. Install all interconnection piping, electrical and control conduits and wiring between equipment and to Main Control Panel.

F. Where Dry Well pumps are indicated on Drawings for aerated sludge digester, install dry well with fabricated safety features to ensure safe access in accordance with OBO Zoning Code for confined space entry.

3.2 PLANT START-UP

A. At time that wastewater treatment system is filled with water or sewage, all power connections have been completed, and all equipment is accepted by Project Director/COR for service, manufacturer's field representative must provide service for 7 calendar days minimum at project site. Manufacturer's representative must check installation and start-up system (including settings controls and performing operational tests). Service manual must have been submitted and available on-site before beginning of start-up.

1. Manufacturer's qualified Field Representative must field test MBBR, after installation, in presence of OBO Project Team engineer, as coordinated by Project Director/COR, to confirm structural and mechanical compliance with Contract Documents.
2. **[Field test DAF system.]**
3. Develop and implement field start-up and testing plan. Include adequate procedures to demonstrate that system meets all performance criteria.

B. Manufacturer's field representative must start-up and test system, adjust and set controls, and provide specified training for minimum period of 30 days on site. This period includes minimum time for demonstration and training identified below, which must not be shortened to address start-up and testing.

C. [Test disinfection processes and facilities prior to producing and using reclaimed water. Tests must include all processes, equipment, and reactors used in production of reclaimed water.]

D. Test water quality to ensure compliance with the Design requirements.

E. Adjust and maintain chlorine dosage based on final effluent online chlorine residual analyzer.

3.3 DEMONSTRATION AND TRAINING

A. Demonstration: After completion of plant start-up, there must be a period of minimum 14-day demonstration phase. Ensure all systems have been functioning properly and adjustments made.

1. Demonstration phase days must be extended, if there are major issues which cannot be resolved in one day in relation to applicable design parameters for the project.

B. Training: Provide training to plant operators at post for operation, laboratory testing, data collection/ management and compliance reporting.

1. 5 days minimum training.

3.4 BASIS OF DESIGN

A. Use of Basis of Design Information: Table 3.4 identifies baseline Basis of Design values. The application of values for listed parameters in the Table must be adjusted for project-specific design as indicated below. In addition, application of certain parameters require adjustment for project-specific design (e.g., type of secondary clarifier, project-specific design for reclaimed water).

1. Invariable: Where application of parameters is identified as "Capacity," values are unaffected by variations in capacity from baseline.
2. Capacity: Baseline Basis of Design assumes plant with Design Average Flow (ADF) of 50 cubic meters per day, including associated hydraulic capacity and waste. Where application of parameters is identified as "Capacity," values for the project-specific system and sizing of system components must be adjusted relative to variation from baseline values included in Table 3.4.
3. Other Factors: A few parameters of site specific application; no baseline values are shown in Table 3.4.

B. References in the Specification Section to Table 3.4 are to be understood in relation to the Paragraph on "Use of Basis of Design Information" above.

TABLE 3.4
BASIS OF DESIGN

PARAMETER	UNIT	VALUE	APPLI-CATION
A: General – Site Specific Conditions			
Site Elevation Above Sea Level (for derating equipment)	Meter above Sea Level	Variable	Other Factors
Air Temperature Range	Degree C	Variable	Other Factors
Wastewater Temperature Range	Degree C	Variable	Other Factors
B: Flows			
Unit Flow per Population Equivalent (P.E.)	L/day/P.E.	200	Invariable
Design Avg. Daily Flow (ADF)	m^3/day	50	Capacity
Population Equivalent for Avg. Flow Conditions	P.E.	250	Capacity

TABLE 3.4
BASIS OF DESIGN

PARAMETER	UNIT	VALUE	APPLI-CATION
Influent Peak Hourly Flow	m^3/hr	8.3	Capacity
Hourly Equalized Flow Rate (ADF/24)	m^3/hr	2.08	Capacity
C: Influent Water Quality			
BOD5	mg/L	200-300	Invariable
TSS	mg/L	200-300	Invariable
Alkalinity	mg/L	60-120	Invariable
TKN	mg/L	20-35	Invariable
TP	mg/L	4-12	Invariable
pH	Standard	6.5-7.5	Invariable
D: Effluent Water Quality			
BOD5	mg/L	<10	Invariable
TSS	mg/L	<10	Invariable
Turbidity	NTU	<2 for 24 hour <5	Invariable
Chlorine Residual (at Entrance to on-Site Reclaimed Water Storage Tank where applicable); for wastewater not being reclaimed, UV may be used in lieu of chlorine for disinfection	mg/L	>1.0	Invariable
E: Influent Bar Screen			
Method of Cleaning	N/A	Manual	Invariable
Size of Vertical Bar Screen	mm	15	Invariable
Vertical Bar Spacing or Hole Opening	mm	25	Invariable
Slope, Degrees from the Horizontal	Degrees	30-60	Invariable
Min Approach Velocity to Prevent Settling	m/s	0.40	Invariable
Max Approach Velocity to Prevent Forcing Material Thru)	m/s	0.90	Invariable
F: Primary Clarifier			
Min Side Water Depth	m	3.0	Capacity
Min Length	m	3.0	Capacity

TABLE 3.4
BASIS OF DESIGN

PARAMETER	UNIT	VALUE	APPLI-CATION
Surface Overflow Criteria for Avg Conditions	$m^3/(m^2.d)$	41	Capacity
Surface Overflow Criteria for Peak Conditions	$m^3/(m^2.d)$	61	Capacity
Weir Loading Rate Criteria at Peak Conditions	$m^3/(m.d)$	250	Capacity
Selected Width	m	2.0	Capacity
Selected Depth of Tank (Depends on Site Hydraulics)	m	4.2	Capacity
Selected Length	m	3.0	Capacity
Volume of Primary Clarifier Tank	m^3	25.2	Capacity
Volume of Water in Primary Clarifier	m^3	18.0	Capacity
Selected Weir Length – Set Equal to Width of Basin	m	2.0	Capacity
Sludge Hopper Min Slope	side walls/ horizontal	1.7/ 1.0	Invariable
Min dimension of Sludge Hopper	m	0.6	Invariable
Sludge Removal Pipe Min Size	mm	150	Invariable
Min Static Head for Sludge Withdrawal	mm	760	Invariable
Min Velocity in Sludge Withdrawal Pipe	mm	0.9	Invariable
Slope Towards Sludge Pump Pit	percentage	4	Invariable
G: Equalization Basin			
Volume of Water in EQ Basin	m^3	21.0	Capacity
Total Volume, including Freeboard	m^3	24.5	Capacity
Side-Water Depth	m	3.0	Capacity
Depth of Tank	m	3.5	Capacity
Length	m	3.5	Capacity
Width	m	2.0	Capacity
Slope towards Sewage Lift Pump Pit	percentage	2.0	Invariable
Volume of Water in EQ Basin	m^3	21.0	Capacity
Maintain min of 1.0 mg/L DO, air supply	$L/m^3.s$	0.16	Invariable
Estimated Volume of Air Needed	L//s	3.4	Capacity

TABLE 3.4
BASIS OF DESIGN

PARAMETER	UNIT	VALUE	APPLI-CATION
H: MBBR 1 and MBBR 2 Process			
Surface Area Loading Rate (SALR)	g BOD/m^2/day	5	Invariable
MBBR Carrier PSA Provided	m^2/ m^3	500	Invariable
Media Volume Required	m^3	4.0	Capacity
Media Fill Fraction	percentage	50	Invariable
MBBR Bio Reactor Volume	m^3	8	Capacity
MBBR Carrier Void Ratio	percentage	90	Invariable
Liquid Volume of MBBR Bio Reactor	m^3	7.2	Capacity
Width of MBBR Basin	m	2.0	Capacity
Side Water Liquid Level	m	2.5	Capacity
Length of MBBR Basin	m	1.6	Capacity
Depth of Tank with 0.5 m Freeboard	m	3.0	Capacity
Number of Bioreactor Tanks	each	two	Invariable
Provide min of two Blowers; one Duty and one Standby	m^3/min	2.5	Capacity
I: Secondary Clarifier: DAF Type			
Flocculator Number of Stages	each	1	Invariable
Number of Flocculators	each	2	Invariable
Flocculator Volume, Each	Liters	1,042	Capacity
Width of Flocculator, Each	m	0.75	Capacity
Length of Flocculator	m	0.75	Capacity
Depth of Flocculator	m	1.85	Capacity
Flocculator Motor	Type	Variable Speed, Gentle Mixing	Invariable
Type of Flocculator	Turbine Mixer	Use two paddle flocculator	Invariable
Total Number of DAF Units	each	1.0	Invariable

TABLE 3.4
BASIS OF DESIGN

PARAMETER	UNIT	VALUE	APPLI-CATION
Width of DAF Units	m	1.5	Capacity
Length	m	3.0	Capacity
Side-Water Depth	m	2.5	Capacity
Depth of Tank	m	3.0	Capacity
Recycle Rate	percentage	15	Invariable
Recirculation Pump	each	1	Invariable
J: Secondary Clarifier: Gravity Type			
Volume	m^3	9	Capacity
Surface Area	m^2	4.3	Capacity
Water Depth	m	5	Capacity
K: Aerobic Digester Tank			
Criteria for Tank Volume (Primary plus Attached Growth – MBBR)	m^3/P.E.	0.1	Invariable
Mean Cell Residence Time Mandated (for 503 B Compliance at 15 deg C)	days	60	Invariable
Estimated Volume for 60 Days MCRT (at 15 deg C)	m^3	50	Invariable
Use two Side-by-Side Tanks with Interconnecting Sluice Gates	m^3	25	Invariable
Side-Water Depth of Aerobic Digester	m	4.5	Invariable
Width of Each Tank of Aerobic Digester	m	1.25	Capacity
Total Width of Both Sides of Aerobic Digester	m	2.5	Capacity
Length of Aerobic Digester	m	4.5	Capacity
Freeboard in Digester	m	0.5	Invariable
Estimated Volume of Aeration Requirements	L/s	25	Capacity
L: Digested Sludge Holding Tank			
Volume of Sludge in Sludge Holding Tank	m^3	3.0	Capacity
Volume of Sludge Holding Tank Considering Free-board	m^3	3.4	Capacity
Depth of Sludge Holding Tank with 0.5 Freeboard	m	4.3	Capacity

TABLE 3.4
BASIS OF DESIGN

PARAMETER	UNIT	VALUE	APPLI-CATION
Diameter of Sludge Holding Tank	m	1.0	Capacity
Days in-between Sludge Holding Tank	days	10	Invariable
Tank to be Vented and Mixed, but not Aerated	N/A	N/A	Invariable
Size of Mixer	hp	2.0	Capacity

END OF SECTION 333700

SECTION 335005 - UNDERGROUND FUEL STORAGE TANKS AND DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide double wall fiberglass fuel storage tanks, piping, and vehicular fuel dispensing equipment for compound or portion of facility.

B. Related Sections include the following:

1. Section 230905 "Instrumentation and Controls for HVAC" for building automation system (BAS).
2. Section 263214 “Engine Generators.”
3. Section 335217 “Motor Vehicle Fuel Dispensing.”

1.2 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) Specification D4021: Glass Fiber Reinforced Polyester Underground Petroleum Storage Tanks.

B. Underwriters Laboratories, Inc. (UL) 971: Outline of Proposed Investigation for Non-metallic Underground Piping for Flammable Liquids.

C. Underwriters Laboratories, Inc. (UL) 1316: Glass Fiber Reinforced Plastic Tanks for the Underground Storage of Petroleum Products, Alcohols and Alcohol-Gasoline Mixtures.

D. National Fire Protection Association (NFPA) 30: Flammable and Combustible Liquids Code and NFPA 31: Standard for the Installation of Oil Burning Equipment.

E. 40 Code of Federal Regulations (CFR), United States Environmental Protection Agency (EPA), Parts 280, Technical Standards and Corrective Actions for Owners and Operators of Underground Storage Tanks.

1.3 SYSTEM REQUIREMENTS

A. Fuel tanks must conform to Chapter 13 of the OBO Mechanical Code (International Mechanical Code as amended by OBO).

B. Loading Capacity:

1. External Loads: Provide tanks designed for pressures from external loads, including soils at side and top of tanks in underground installation configuration.
2. External Hydrostatic Pressure: Empty tanks must be able to be buried at maximum depth in ground such that there is distance of 2.1 meters of backfill between top of tanks and

ground surface leveled to surrounding ground elevation. Tanks must be able to withstand, with tank safety factory of 5:1, against general buckling after being placed in tank hole where there is total flooding.

3. Surface Loads: Install tanks in accordance with tank manufacturer's loading installation instructions, and in such a way that tanks are able to withstand H_2O level surface loads of 14,500 kilograms kg per axle. Isolate turbine enclosures from direct traffic loading.
4. Internal Load: Both primary and secondary tanks in double wall fiberglass storage tanks must be able to withstand a pressurization test of up to 35 kPa of air pressure prior to installation and, once installed, a hydrostatic test with safety factor of 5:1.
5. Design tanks to support accessory equipment mounted through DN 100 NPT couplings on manway cover or shell wall, with maximum downward load of 1090 kg and 136 kg respectively when installed in accordance with tank manufacturer's recommendations and limitations.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Storage tank, protective coatings, level and leak monitoring and alarm system, tank gauges, overfill protection system, containment manhole, shutoff valves, submersible fuel oil pump, and fuel fill panels.

B. Shop Drawings: Submit shop drawings for the following:

1. Tank System: Include critical dimensions and show locations of fittings and accessories that are part of the double wall fiberglass storage tank and associated storage tank system.

   a. For each tank, include couplings, manholes, turbine enclosures, manways, anchor hold down straps, double wall piping from remote fueling point in secure compartment with locked access to final fuel delivery point, liquid level indicator, all sensors in system and control panels.

2. Fuel Panels: Include fuel fill panel installation detail showing front closed, front open, and back and side views of fill panels. Show all piping and conduit, junction boxes, electrical connections, and alarm panel.
3. Level and Leak Monitoring and Alarm System: Include wiring diagrams for connection of various tank sensors to system panel.

C. Calibration Charts: Include Manufacturer’s latest calibration charts for each tank capacity and diameter specified in Liters. Include copy of this information also in Storage Tank Management Plan.

D. Qualification Data: For manufacturer and installer.

E. Factory Quality Control Checklists:

1. Manufacturer submit must provide leak detection test checklist used at factory, as identified in the Part 2 Article on FACTORY QUALITY CONTROL, to Project Director/COR upon delivery of tanks at final delivery site.
2. Checklists associated with re-tests must also be submitted to Project Director/COR at same time.

F. Field Report: For start-up service recording inspections and results of tests.

G. Installation Instructions and Checklists: Include Manufacturer's installation instructions for underground fuel tanks, fuel system piping, and level and leak monitoring and alarm system. Include copy of this information also in Storage Tank Management Plan.

1. System supplier must submit comprehensive checklist of quality and safety items critical to system and certify that installation has been done in accordance with contract requirements and local applicable fire and environmental codes.

H. Maintenance Data: For tanks, include list showing recommended maintenance frequency for system components.

1. Provide spare parts lists required for each element of fuel system.

I. Storage Tank Management Plan (STMP): Include the following content and organization in plan:

1. Introductory Material:

a. Title page with title "Storage Tank Management Plan (STMP)," Post name for which plan applies, and month and year of accepted plan.
b. Table of Contents and List of Appendices. Include major and minor headings used throughout STMP.
c. Executive Summary that is appropriate for material contained in STMP. Include statement of purpose of STMP and review frequencies for update that should be followed.

2. Section 1 – Introduction:

a. Explain particular details about Post where storage tank systems are located, list of equipment that depends on storage tanks for dependable supply of fuel, and specific details about storage tank systems at Post.

3. Section 2 – Regulations:

a. Summarize regulations that govern installation and operation of Storage Tank. Include appropriate references to CFR Part 280 and local standards.
b. Outline specific record keeping requirements for proper operations and maintenance of storage tank system and recommend procedure for maintaining these files.
c. Include descriptive paragraph for each storage tank subsystem, including identification of regulations applying to each of those subsystems.

4. Section 3 – Responsibilities:

a. List by staff position those responsible for various aspects of record-keeping and operations and maintenance of storage tank system.
b. Include Table with points of contact and associated contact information.

5. Section 4 – Underground Fuel Storage Tank Systems:

a. Identify specific conditions or requirements by local ordinances or permits for these tanks.
b. Maintain historical record of all closed tanks.
c. List all existing tanks with location, use, date of installation, capacity, and similar information.
d. Specify forms to be used for record keeping activities associated with operations and maintenance of tanks.
e. Specify standard operating procedures for various operations associated with tank systems.
f. Specify maintenance requirements of tank.

6. Section 5 – Spill Prevention, Control, and Countermeasure Plan (SPCC):

a. Identify oil discharge risks, spill prevention measures, and contingency plans. Model after guidance of 40 CFR 112.7, paragraphs (a) through (d), which sets out various prevention and control measures that Plan should address. Plan must be prepared and signed by professional engineer familiar with fuel system and associated regulatory standards.

7. Section 6 – Appendices:

a. Acronyms and abbreviations used in STMP.
b. Installation checklists and warranty information.
c. Tank chart for each tank.
d. Product literature associated with various components of system. Specific parts used must be highlighted or noted to readily identify installed parts.
e. Copies of all applicable permits. If there are no required permits, a page must be inserted that contains wording that indicates this condition.
f. List of qualified contractors who can repair various aspects of tank system. Identify which portion of system each contactor can perform, and appropriate contact information.
g. Certifications of Leak Detection Evaluations for various aspects of system, and test used to determine whether tank system is tight. Refer to www.epa.gov/oust/pubs/ldlist.htm.
h. List of monitoring wells associated with present and past tank systems and identifying their current status. Include unique labels for each well, and specific location identifier. This requirement only applies if monitoring wells have been used.
i. Copy of EPA's publication, "Operating and Maintaining Underground Storage Tank System," EPA 510-B-00-008.

1.5 QUALITY ASSURANCE

A. Basis of Design: This Section identifies "Basis of Design" for various equipment and components. Other products from the identified manufacturer or other manufacturers are acceptable which conform to requirements of this Section.

B. Comply with the OBO Electrical Code (NFPA 70, "National Electrical Code" as amended by OBO).

C. Listing and Labeling: Provide voltage regulators specified in this Section that are listed and labeled. Listed and Labeled in accordance with Chapter 1 of the OBO Electrical Code by testing agency acceptable to Project Director/COR based upon input from OBO/PDCS/DE engineer, and marked for intended use.

1. Fuel Storage Tanks:

a. Certification Plates: Affix UL Labels for petroleum products affixed to each tank.
b. All monitoring equipment, including reservoirs and electronic controls, must be UL Listed.
c. Provide tank manways with UL Listed gaskets, bolts, and cover.
d. Tank Laminate: UL Listed for compatibility with monitoring fluid.
e. Containment Collar Sensor: Electrical components must be U. L. listed or accepted.
f. Flexible Connectors: Provide UL Listed flexible connectors at equipment.

D. Manufacturer Qualifications: Manufacturers must have produced similar systems for at least the past ten years.

E. Installer Qualifications: Installers who have been trained and certified by manufacturer for installation of systems required for this project.

1.6 DELIVERY AND HANDLING

A. Conform to instructions of storage tank manufacturer's installation manual regarding movement and temporary placement of storage tanks from point of distribution to point of installation. Tanks must only be moved using all manufactured lug lifts with guidelines that are correctly angled with respect to tank surface in accordance with manufacturer's instructions. Do not lift or hoist underground storage tanks while under pressure. Do not move tanks with chains or cables around tank, and do not be roll or drop. Protect tanks from damage in transit.

1.7 WARRANTY

A. General: Manufacturer's standard form in which manufacturer agrees to repair or replace components which fail in materials or workmanship within specified warranty period.

B. Fuel Storage Tanks:

1. Provide written warranty executed by tank manufacturer.

2. Warrant tanks, secondary containment collar, and integrally mounted monitoring reservoirs against failure due to internal/external corrosion and against structural failure.

   a. Warranty Period: 30 years from Substantial Completion.

C. Fuel Piping and Related Equipment:

1. Provide written warranty executed by manufacturer of fuel piping and related equipment. Warrant piping and related equipment against failure, including cracking, break-up, collapse, and leakage.

   a. Warranty Period: 30 years from Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Commencing at the contract's Substantial Completion date for a period of one calendar year with a renewable option for an additional year, provide proposal for system maintenance service based on manufacturer's recommended daily, weekly, quarterly, semi-annual, and annual maintenance activities. The proposal must be submitted to the COR/Project Director at least 120 days prior to Substantial Completion.

B. The proposal must be inclusive of filtration, underground storage tanks, submersible and recirculation pumps, transition pumps, and control panels using factory-trained personnel.

PART 2 - PRODUCTS

2.1 DOUBLE WALL FIBERGLASS STORAGE TANKS

A. Basis of Design: Containment Solutions, Inc.; Xerxes Corporation.

B. Provide UL 1316 labeled tanks, including openings for manual stick gauging, fill pipe leading to remote fill port, vapor return pipes, tank vent pipe, fuel oil/gasoline suction pipes, fuel oil return pipes, gasoline vapor return pipes, and applicable fuel oil/gasoline gauge tubing. Locate strike plates at bottom of tanks under each opening provided at top of tank.

C. Product Storage Requirements:

1. Vent all primary tanks. Design tanks for operation at atmospheric pressure only, except for use with vapor recovery systems, at pressure or vacuum of approximately 6.9 kPa.
2. Tanks must be capable of storing liquids with specific gravity up to 1.1.
3. Maximum temperature: Tanks must be capable of storing gasoline, alcohol blended gasoline (with up to 100 percent methanol or ethanol), oxygenated fuels (up to 20 percent MTBE), AV-gas, jet fuel, motor oil, kerosene, or diesel fuel at ambient underground temperatures not to exceed 65 deg C at the tank's interior surface.
4. Tanks must be chemically inert to all petroleum products.

D. Monitoring Capabilities:

1. Tanks must have space between primary and secondary shell walls to allow for free flow and containment of all leaked products from primary tank.
2. The following continuous monitoring condition must be compatible with cavity between inner and outer tanks:

   a. Vented to atmosphere.
   b. Vacuum: - 34.5 kPa.
   c. Positive air pressure: 34.5 kPa maximum.
   d. External Hydrostatic Pressure: 2.1 m maximum groundwater head pressure over tank top.

3. Provide tanks having 1.83 m and larger diameter with integrally mounted reservoir installed on tank for factory installed, continuous hydrostatic monitoring. Construct reservoir of fiberglass reinforced plastic (FRP) materials. Tanks having 1.22 m diameter must use 0.1016 m diameter riser pipe screwed into 0.1016 m annular space fitting as reservoir.
4. Design tanks with access to tank bottom between primary and secondary tank walls through DN100 NPT rib-mounted fitting, or through reservoir if reservoir is mounted at end of tank. All tanks, except for 1.22 m diameter tanks, must include one DN50 NPT fitting in secondary tank only for in-plant test purposes.
5. Double wall tank monitor must be capable of detecting breach in inner or outer tank wall under the following installed conditions:

   a. When inner tank is empty.
   b. When inner tank is partially, or completely full, and groundwater table is below tank bottom.
   c. When inner tank is partially or completely full and tank is partially or completely submerged in groundwater.

6. Leak detection features of monitoring system must be capable of detecting leaks in primary or secondary tank as small as 0.38 liters per hour with 99.9 percent probability of detection and with less than 1.3 percent probability of false alarm.

2.2 TANK ACCESSORIES

A. Flanged Manways:

1. Each manway must be 550 mm inner diameter. Provide manway with each tank. Locate manways in accordance with recommendations of tank manufacturer.

B. Sounding Rod: Provide wooden gauging rod with plastic tip, graduated at 0.25 cm intervals. Use this gauging rod in conjunction with manufacturer-supplied tank chart for calculating number of liters of petroleum product in tank.

C. Hydrostatic Monitor Accessories:

1. Brine Antifreeze Solution: Factory install, with the following characteristics:

   a. Brine Solution: BAS-30 designation
   b. Chemical Composition: 30 percent or more calcium chloride, 1 percent to 3 percent potassium chloride, and 1 to 2 percent sodium chloride. Balance of solution must be water.
   c. Visual appearance: Green in color, odorless fluid.
   d. Specific gravity: 1.272-1.317 at 15.6 deg C.
   e. Color: Color of brine solution must be in sharp contrast to tank color to facilitate easy visual checking for tank damage.

D. Turbine Enclosure:

1. Watertight turbine enclosure must consist of fiberglass reinforced plastic (FRP) enclosure body and FRP reducer with o-ring groove and o-ring gasket. Reducer opening must be large enough (minimum of 711 mm diameter) to allow for removal of a 559 mm diameter manway lid. Turbine enclosure must be minimum of DN1050, and maximum of DN1200, and must be capable of mounting to DN1050 secondary containment collar. Enclosure body must be capable of joining to 1067 mm or 1219 mm diameter secondary containment collar with leak-tight adhesive joint. Reducer must be capable of joining to enclosure body with external leak-tight adhesive joint to allow for field installation of adhesive without entering enclosure.
2. Turbine enclosures must be of variable length to correspond to required burial depth for tanks. Mark cut lines for field trimming on top 300 mm of turbine enclosure in 75 mm intervals.
3. Construct turbine enclosure lid of high-density polyethylene or other non-corrosive product, with top diameter to match turbine enclosure. Turbine enclosure lid outer diameter must be small enough to be removed through 914 mm diameter street box. With lid installed, assembly must provide watertight seal under standing water up to 305 mm over lid.
4. Turbine enclosure lid must include friction-fit lid constructed of high-density polyethylene or other non-corrosive product, with outside diameter of DN675. Lid must be able to support person standing on lid without damage to lid. One of lid handles must be offset to aid in removal of lid; the other must be centered on lid.
5. Manhole frame and cover over turbine enclosure lid must be composite, H-20 rated type, sized DN900 or larger. Rain tight lids must be provided with factory gasket and bolts or cams locks. Use stainless steel hex head bolts or cam locks to secure manhole cover for limited access. Provide two sets of tools to be used with lid or two wrenches for each type of cover to Project Director/COR. Top seal caps on all tank opening within manholes must be lockable.
6. Turbine Enclosure Adhesive Kit: Kit must be manufacturer's standard with quantities as recommended by manufacturer.

E. Flexible Entry Boots for Conduit:

1. Flexible entry boots must be UL listed for this application.
2. Fit containment chambers with conduit entry seals that are flexible and semi-absorbent to ground movement.

3. No metallic components must be exposed to ground.
4. Materials of flexible boot assembly must be chemically compatible with and resistant to materials and liquids encountered.

F. Secondary Containment Collar: Secondary containment collar must be fiberglass reinforced plastic. Collar must be DN1050 and factory installed. Collar must include sensor-mounting bracket.

G. Containment Collar Sensor: Pre-assemble containment collar sensor, ready to wire. This float switch sensor must be capable of detecting a 13 mm or more accumulation of liquid (water or product) in turbine enclosure. Construct float switch of Buna-N. House the float switch in plastic casing and include mounting clamp.

H. Ladders: Standard ladders supplied by tank manufacturer.

I. Overfill Protection System for Gravity Fill Systems:

1. Basis of Design: EBW Auto Limiter II series with EBW Remote Fill Kit.
2. Provide automatic shut off valve designed to be installed at tank. Assume that 150 L of fuel will be in line at any time and will need to be accounted for during remote shutoff procedure. Valve must reduce flow into tank by 90 percent at first stage which varies from approximately 85 percent (for tank size of 3,785 L) to 92 percent (for tank size of 37,850 L and larger) of tank capacity; reduction must be field adjustable. Second stage must vary from approximately 87 percent (for tank size of 3,785 L) to 94 percent (for tank size of 37,850 L and larger) of tank capacity. Once the second stage is reached, completely shut off the flow.
3. Construct valve body of cast aluminum, and internal guide rod of stainless steel.
4. Valve must allow manual stick gauging of storage tank after valve has reached complete shut off.
5. Provide remote fill kit for use with automatic shut off valve.

J. Overfill Protection System for Pumped Fill Systems:

1. Basis of Design: Morrison Bros. Co. 9095AA0300 AV
2. Aluminum body valve that closes when fuel level reaches a preset warning level, with built in bleed hole for pressure relief when valve closes and anti-siphon protection.
3. Aluminum drop tube compatible with valve

K. Tank Lifting Lugs: Provide lifting lugs on all tanks. Lugs must be capable of withstanding weight of tanks with a safety factor of 3.

L. Fittings Threaded – NPT:

1. Threaded fittings on UL Listed tanks for storage of petroleum products must be located in manway lid on tank, mounted within 300 mm of tank top centerline, and constructed consistent with requirements of the UL Listing. Provide fittings with threaded cast iron plugs.
2. Threaded fittings to primary tank cavity must be DN100 or DN150. Standard threaded fittings must be half couplings. Use reducers for smaller sizes.

3. Thread Standards: Threaded fittings must have machine tolerances in accordance with ANSI Standards for each fitting.
4. Strength: NPT fittings must withstand minimum of 204 Newton-meters of torque and
5. 1357 Newton-meters of bending, both with a 2:1 factor of safety.
6. Terminate rigid vertical piping 102 mm from bottom of primary tank.

M. Anchor Hold Down Straps:

1. Provide FRP anchor hold down straps and turnbuckle clamps for each tank. Number and location of straps must be as required by tank manufacturer. Each strap must be capable of withstanding buoyancy load for tank diameter as indicated on Drawings:

   a. 1.22 m diameter (1,905 kg).
   b. 1.83 m diameter (8,165 kg).
   c. 2.44 m diameter (11,340 kg).

2. Straps must be standard as supplied by tank manufacturer.
3. NOTE: Include the following for projects without remote filling.

N. [Containment Fill Manhole:

1. Manhole frame and cover lid must be composite, H-20 rated type, sized DN300 or larger. Rain tight lids must be provided with factory gasket and bolts or cams locks. Use stainless steel hex head bolts or cam locks to secure manhole cover for limited access. Provide two sets of tools to be used with lid or two wrenches for each type of cover to Project Director/COR. Interior of manhole must have one-piece HDPE bellows liner attaching to top and bottom of manhole. Manhole must have one piece fiberglass base with DN100 bottom connection for vapor recovery use or product fill use. Fill manholes must contain spring-pull drain assembly for emptying manhole basin of spilled fuel.
2. Basis of Design: Emco Wheaton A1003-001 with drain for fill lines and A1003-002 without drain for vapor return lines.]

O. Tank Monitoring Manholes:

1. Manhole frame and cover lid must be composite, H-20 rated type, sized DN300 or larger. Rain tight lids must be provided with factory gasket and bolts or cams locks. Use stainless steel hex head bolts or cam locks to secure manhole cover for limited access. Provide two sets of tools to be used with lid or two wrenches for each type of cover to Project Director/COR.

P. Fill Caps: Bottom opening must have self-aligning, toggle-action design for easy coupling fill caps. Caps must be lockable, cam-and-groove type caps made of aluminum or FRP material with Buna-N seals. Toggle pins and cams on caps must be stainless steel, and links must be plated steel. Vapor recovery line caps must have impregnated orange color for identification.

1. Basis of Design: Emco Wheaton A97 for tight fill product caps and A99 for vapor adapter caps.

2.3 PIPING

A. General: Underground fill pipe, tank vent pipe, vapor return pipe, fuel oil supply pipe, and fuel oil return pipe must be durable wall fiberglass piping or semi-rigid double-contained pipe.

1. Piping components must be UL 972 for use as underground containment piping for gasoline, alcohol blended gasoline (with up to 100 percent methanol or ethanol), oxygenated fuels (up to 20 percent MTBE), AV-gas, jet fuel, motor oil, kerosene, or diesel fuel products.
2. Piping must be rated by UL to pressure of 690 kPa at 66 deg C.
3. Fittings and accessories must be provided by manufacturer and rated to the greater of 344 kPa or 1.25 times the working pressure.

B. Double Wall Fiberglass Piping

1. Materials:

a. Basis of Design: FRP epoxy made by filament winding system by Smith Fiberglass Products, Inc.
b. Fittings must be FRP epoxy made by compression molding process. Fittings must be two-piece construction that will be bonded together at final assembly. Fasteners may be used to assemble fitting pieces until adhesive cures. Integrity of fiberglass system must not rely on metallic components once adhesive is cured.
c. Adhesive must be epoxy system that will develop adequate strength at 18 deg C to meet all strength requirements. Below 18 deg C, make available means of heat-assisted adhesive curing.
d. Provide containment fittings with 20 mm NPT outlets in bottom, rated for 68.9 kPa for pressure testing of containment system and draining secondary system.

C. Semi-Rigid, Double-Contained Pipe

1. Materials:

a. Basis of Design: UPP Pipe manufactured by PetroTechnik.
b. Coaxial semi-rigid high-density polyethylene with nylon permeation barrier.
c. Fittings must be manufacturer's secondary containment and entry fittings. Pipe connections and entry fittings must be fusion welded using manufacturer's electro fusion welder.
d. Provide fusion welded secondary containment fittings with test ports for pressure testing of containment system and drainage secondary system.

D. Schedule 40, Steel Piping:

1. Above ground fuel oil suction, return piping, vent piping and all piping in tanks must be Schedule 40 (USA) seamless black steel, with butt welded joints for piping DN40 and larger, and socket weld joints for piping DN32 or smaller. Fuel oil suction and return piping must not be smaller than DN20, but may be reduced to size of tapping in apparatus as close as possible to apparatus. Return piping must be same size as fuel oil suction piping unless otherwise required by manufacturer. Provide separate suction line from fuel oil

storage tank to generator day tank for each generator day tank with integral pump. For "prime power" single generator installations, provide dual suction lines connected together inside Equipment Room with separate gate valve and check valve in each suction line.

a. Provide piping entering building with dielectric unions to prevent transmission of field current to building piping.

E. Coupling Kits: Provide by fuel pipe manufacturer for joining piping.

F. Flexible Connectors at Equipment: Provide UL 536 and NFPA 30 and 30A approved 321A, stainless steel flexible connectors with 0.38 mm thick wall and carbon steel Schedule 80 male hex NPT or EZ Fit/Quick-Connect ends on fuel supply piping at connection to equipment. Pressure requirement is 344.5 kPa in accordance with UL. Seals must be MH25059 listed, specially engineered polymer to withstand aromatic petroleum products, alcohols, and alcohol-gasoline mixtures.

G. Sumps: Sumps must be watertight and accessible, constructed of polyethylene or fiberglass. Use grade level sumps for transition into and out of ground for piping. Provide sump top, lid, gasket-seal joints, and sump entry boots for pipe penetrations. All below grade entries must be made with fusion fittings or fiberglass entry fittings. Each sump must be provided with an inspection port that allows inspection of the leak sensor as well as water/fuel removal.

2.4 LIQUID LEVEL AND LEAK MONITORING

A. Basis of Design: The following components from Pneumercator Company:

1. Electronic Fuel System Control Panel: Model TMS4000.
2. Tank Level Sensor/Transmitter: Model MP450S.
3. Tank Leak Sensor: Model RSU 800.
4. Turbine Enclosure Leak Sensor: Model LS 600 LDBN or ES835-200F with sensor fault detection.
5. Remote Alarm Panel: Model RA200KRM or RA400 for diesel and RA 300KRM explosion proof for gasoline.

B. General:

1. Provide multi-tank liquid level and leak monitoring system, capable of monitoring tank levels, tank leaks, and sump leaks. System must consist of the following:

a. Electronic control panel.
b. Tank liquid level transmitter assembly for each tank.
c. Tank leak sensor for each tank capable of detecting break in inner and outer tank.
d. Turbine enclosure leak sensors for each tank turbine enclosure capable of detecting leak in enclosure.
e. Sump leak sensors capable of detecting fuel and water in sumps.

2. Principle of tank liquid level measurement must be by Direct Lift Magnetic Float with Manetores Resistance Transmitter.

3. Provide all wiring, including wiring from power source to control panel, and from control panel to probe assemblies and remote alarm console.
4. Provide remote alarm panel with locked access to inform truck operators when each tank approaches full level.

C. Electronic Fuel System Control Panel:

1. Provide controls and display for multiple tanks in single NEMA enclosure suitable for wall mounting. Use NEMA 12 for indoor applications and NEMA 4X for outdoor applications.
2. Provide front face of the panel with:

   a. Color Touchscreen display showing each tank's liquid level in liters.
   b. Normal/Alarm LEDs visible from at least 20 meters.
   c. Indicating lights for each tank's high, low and critical tank level alarms.
   d. Indicating lights for each leak sensor of each tank, tank turbine enclosure, and sumps.
   e. Horn and horn reset button.
   f. Touch keypads must facilitate selection of tank, and for each tank keypads must facilitate selection of testing, adjusting calibration, setting alarm limit, and operating in each mode.
   g. Provide offset adjustment for easy field correction of level sensor installation height error.
   h. Control panel must use a microprocessor-based controller and be user programmable to specific tank configurations encountered.
   i. Control resolution must be within 3 mm of liquid level in each tank.
   j. Provide Modbus protocol for remote interface to Building Automation System (BAS). Refer to Drawings for interface schematic.
   k. Leak and level transmitter installation must be intrinsically safe.

D. Tank Level Transmitter Assembly:

1. Each tank assembly must contain resistive sensor/transmitter element bonded to 10 percent glass-filled polycarbonate track, and hermetically sealed within stainless steel vertical tube suspended into tank through a DN100 opening. Provide magnetic float guided along tube that continuously senses liquid level position to 3 mm accuracy, unaffected by conductivity, temperature, pressure, specific gravity, or other liquid variables.
2. Provide float for water detection that rests at bottom of tube to detect water in range of 25 to 75 mm off tank bottom.
3. Wiring to electronic control panel must be 5 conductor and made through DN25 opening in explosion proof housing provided integral to top of tank assembly.

E. Tank Leak Sensor:

1. Sensor must consist of single float assembly capable of detecting breaks in inner or outer tank under all conditions. Single float and its stem must be of non-corroding PVC to withstand reservoir brine solution, and shielded by PVC outer cylinder which rests on reservoir.

2. Wiring to electronic control panel must be 2 conductor and terminated at leak sensor using watertight connections.
3. Leak sensor must actuate when brine solution in reservoir either falls below 50 mm, or rises above 280 mm.

F. Turbine Enclosure and Sump Leak Sensors:

1. Each leak sensor must be simple, mechanical float switch input to electronic control panel, consisting of magnetic, Buna-N float encased within stainless steel outer shroud, and terminated with 2 conductor wire.
2. Leak sensor must actuate above 13 mm of liquid along probe.

G. Remote Alarm Panel:

1. Alarm Panel must consist of solid-state electronic circuitry housed in wall mountable, weatherproof NEMA 4 enclosure for receiving signals from electronic control panel on overfill tank level and leak status.
2. Panel must include alarm horn, red alarm status lights, reset button to silence horn and test button to demonstrate working condition.

2.5 FUEL OIL SHUT-OFF VALVES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Crane
2. Nibco
3. Jenkins

B. Provide hand-operated valves at fuel oil pump discharge and check valves at suction side so that fuel oil may be shut off and fuel oil pump removed. These valves are in addition to automatic valves.

C. Provide butterfly tank isolation valve in aboveground section of remote fill pipe just inside perimeter wall.

D. Where multiple supply tanks are providing fuel to single destination, provide automatic valve on each return line controlled by pump control panel, configured to be normally closed. Return valve on selected supply tank must open upon call for fuel from that tank, assuring that any return/overflow fuel returns to its originating tank.

2.6 SUBMERSIBLE FUEL PUMPS

A. Basis of Design: Red Jacket Standard Series; Franklin Fueling FE Petro.

B. General: Submersible pumps for handling low viscosity, volatile solvents from underground storage tanks which require explosion-proof pumping equipment.

C. Description:

1. Pump must be of submersible centrifugal type which installs through standard 100 or 150 mm threaded tank opening. Size must vary, depending upon required flow rates and head loss of given piping system. See equipment schedule on Drawings for additional characteristics.

D. Mechanical Features:

1. Pump:

a. Pump must be two, three or five stages, depending upon required flow rate, and must be self-lubricating and easily removed from storage tank without disconnecting discharge piping.
b. Pump and motor assembly must be readily separable from pump column pipe to allow for simple field replacement of pump and motor.

2. Impellers and Diffusers:

a. Impellers must be either splined or keyed to pump shaft to provide positive, non-slip rotation.
b. Diffusers must be tightly secured to lower motor bearing housing to prevent rotation.

3. Pump Intake Inlet:

a. Pump intake inlet must be horizontal to prevent drawing sediment from tank bottom into pump inlet.

4. Manifold Head Assembly:

a. Manifold assembly must be completely sealed against product leakage into ground and exterior water leakage into storage tank.
b. Discharge outlet must be standard DN50 on models that install through DN100 tank openings, and DN75 on models which install through DN150 openings.
c. Head must have built-in air eliminator, line check valve, pressure relief valve and must contain built-in siphon primer when required.

5. The Siphon System:

a. Capable of drawing 625 mm of mercury vacuum through venturi. Siphon must incorporate siphon check valve to maintain siphon action after pump has been turned off.

E. Electrical Features:

1. 100 mm size: Motor must be single phase, permanent split phase capacitance type, continuous duty, rated explosion-proof in Class 1, Group D, flammable solvents. Hermetically seal motor windings against leakage of product or moisture and provide

thermal overload device with automatic reset built into motor windings for motor cut-off when motor temperature reaches level which may cause damage to motor.

2. 150 mm size: Motors must be single or 3 phase. Single-phase motors must be capacitor run. All horsepower motors must be explosion-proof rated for use in Class 1, Group D, flammable solvents. Hermetically seal motor windings to protect against leakage of product or moisture into motor and provide thermal overload device with automatic reset built into motor for cut-off when motor temperature reached level that may cause motor damage. Single-phase models must be supplied with motor control box that provides proper capacitors, relays and overload protection.
3. Connections:

    a. Motor must have quick-disconnect type male/female connector, readily separable for servicing without cutting or splicing of conducting wires.
    b. Wiring connections to motor, including capacitor, must be disconnected by quick-disconnect. Reconnecting motor to column pipe must use alignment dowel pin for positive realignment of electrical male/female connector.

F. Construction:

1. Accessibility:

    a. Components must be designed and assembled to facilitate disassembly and servicing from above without disrupting discharge piping.

2. Assembly Order:

    a. Assemble pump with pump inlet and impellers at bottom for maximum liquid draw. Mount motor above pump inlet so that motor is both cooled and lubricated by liquid flow past motor.

3. Construction for Pumps with l00 mm Tank Opening:

    a. Packer/Manifold Head: Cast Iron.
    b. “O-Ring” Elastomers: Buna-N.
    c. Diaphragms: Viton.
    d. Check Valve Seat: Aluminum.
    e. Column Pipe: Steel Pipe.
    f. Conduit Pipe: Aluminum.
    g. Discharge Head: Cast Iron.
    h. Pump Motor:

        1) Outer Shell: Aluminum.
        2) Stator: Stainless Steel.
        3) Rotorshaft: Stainless Steel.
        4) Impellers and Diffusers: Celcon Acetal copolymer.
        5) Motor Bearings: Carbon.

4. Construction for Pumps with150 mm Tank Opening:

a. Packer Head: Cast Aluminum.
b. Manifold: Cast Iron.
c. "O-Ring" Elastomers: Buna-N or Viton.
d. Column Pipe: Steel.
e. Conduit Pipe: Steel.
f. Discharge Head: Cast Iron.
g. Pump Motor:

1) Outer Shell: Stainless Steel.
2) Impellers: Cast Aluminum
3) Diffusers: Celcon Acetal copolymer or cast iron.
4) Motor Bearings: Carbon.

G. Performance: Actual flow rates must be within 5 percent of published performance curves for each pump model.

H. Provide manufacturer's standard control box for model and pump size selected when pump is not powered by fuel controller.

2.7 SUBMERSIBLE PUMP DUPLEX CONTROLLERS

A. Basis of Design: Simplex, Inc.; Phillips.

B. General: Provide PLC-based duplex pump controllers. Controller must receive level signals via 4-20 mA signals for leak and level monitoring panel. Utilizing these signals, the controller (when receiving call for fuel from day tanks, dead-man switch for fire pump tank, or boilers) must:

1. Open inlet solenoid valve on device calling for fuel.
2. Open return line automatic valve on tank selected.
3. Activate lead submersible pump on main tank selected.

C. Control Panel Construction:

1. NEMA 1 or 3R rated wall-mounted box of 1.90 mm (14 gauge) steel with hinged access doors, and conduit entry areas as needed with terminal strips for connection to remote day tank level controllers.
2. Duplex pup controller for activation by level controller on remote day tank.
3. Fully labeled switches and indicator lamps or Touchscreen detailing system status and operating mode.
4. Provide dry alarm contacts and Modbus protocol for remote annunciation and building maintenance interface.
5. Pump motor starter, full voltage type, non-reversing, with overload relay and circuit breaker.
6. Power available indicator.
7. Pump running indicators.
8. Pump failure indicators.
9. Audible alarm horn with silence push-button.
10. Alarm reset push button.

11. Running time meter, each pump.
12. Control power transformer if voltage is other than 115 VAC, 1 phase, 60 Hz.
13. Power inlet to control cabinet must be interlocked to door-mounted main disconnect switch, which is mechanically interlocked such that power must be disconnected prior to opening enclosure.
14. Provide system with isolation-type control power transformer with fused primary. Subdivide control power circuits into discrete fused branches such that critical circuits are isolated among each other and from non-critical circuits.
15. Provide one flow switch on outlet of each submersible pump or each pair of duplex submersible pumps. Use switches to sense for proper pump operation by control system. Switches must be bronze construction, shuttle/reed switch type, 2756 kPa rated.

D. Function – General:

1. Pump controller must automatically select lead and lag pump on each underground storage tank based upon run-time log to allow equal run time for each pump. Upon requirement for fuel, "lead" pump must be energized. If "lead" pump failure occurs, failure alarm must be sent to Building Automation System (BAS) through level/leak detection controller and "lag" pump must be energized; see Section 230905 "Instrumentation and Control for HVAC" for BAS. If "lag" pump failure occurs, failure alarm must be sent to BAS through level/leak detection controller. When demand for fuel is satisfied, pump controller must de-energize operating pump. Status condition for each pump must be relayed to BAS through level/leak detection controller. Status categories must include Pump Auto (available for operation), Pump Running, and Pump Failure
2. If fuel level in underground fuel oil storage tank falls below low-low level (LLL), pump controller must terminate pumping and send alarm signal to BAS. When fuel level in fuel oil storage tank has risen above reserve level, system must switch back to "lead" storage tank.
3. If there are multiple supply tanks for main system, pump controller must control pumps on each, and equalize run time where feasible. If first main has low fuel level, pump controller must select next main tank with sufficient level.
4. Pump controller must receive leak and level signals from all main tanks and all day tanks.

E. Function for Dedicated Pumps for PCC Generator Day Tank:

1. PCC generator day tank must have dedicated stand-along pump controller that operates dedicated PCC fuel pumps. Mount at one of underground fuel storage tanks. This underground fuel oil tank must have low-low level indicator set at fuel reserve required for PCC for non-PCC fuel controllers.
2. Pump controller must operate in accordance with general function requirements above, except that this Pump Controller must not report to BAS.

2.8 [WALL-MOUNT REMOTE FUEL FILL PANELS

A. Basis of Design:

1. Fuel Fill Panels: Fairfield Industries, Model RFP-24 with one or two ports.

2. ISP Automation, Inc., Model WFB-SS1.

B. Pre-Fabricated Metal Panel:

1. Lockable access door.
2. Remote alarm panel signaling device.
3. Liquid tight conduit thru rear of panel.
4. 100-mm dry-break fill cap and adaptor. Provide one female adapter for each size of dry-break.
5. Fuel piping entry at rear of panel.
6. 15-mm steel pipe drain fitting at base of panel with rear outlet.
7. Maximum two piping ports per panel.]

2.9 [AT-GRADE REMOTE FUEL FILL BOX

A. Basis of Design: Fairfield Industries, Model RFTCN3/N4-WT with Padlock

1. 5-gallon spill bucket with 14GA secondary containment and termination chamber for piping secondary containment
2. Entries sized for piping.
3. 100-mm dry-break fill cap and adapter. Provide one female adapter for each size of dry-break.]

2.10 FACTORY QUALITY CONTROL

A. Precision Testing:

1. Test leak detection performance of monitoring system using UL test procedure at factory prior to shipping to detect leaks in primary or secondary tank. Test must be performed by qualified independent agency.
2. If tanks fail to pass either monitoring system test at factory, qualified personnel supplied by tank manufacturer must repair all leaks in primary and secondary tanks. Tanks must then be re-tested.
3. Hydrostatic Monitoring System must conform to Environmental Protection Agency (EPA) criteria associated with precision tank tests.

PART 3 - EXECUTION

3.1 GENERAL

A. Install tanks and piping, including appurtenances, manholes, and accessories as indicated on Drawings.

1. Verify location of equipment conforms to requirements of Chapter 13 of the OBO Mechanical Code.

2. Install wiring in conduit with long radius bends at all changes in direction. Comply with Division 26 requirements for conduit.

3.2 TANKS

A. Installation:

1. Install tanks in accordance with manufacturer's installation instructions. Complete installation checklist provided tanks, submit to Project Director/COR upon completion of installation.
2. Install fuel storage tanks below frost line, with tanks set upon bed having depth ranging from 300 mm to 600 mm. Anchor tanks to dead-man anchors, which must be sized and spaced in accordance with manufacturer's installation instructions, using manufacturer-provided anchor hold-down straps of quantity recommended in installation instructions.
3. Set storage tank must on concrete pad and anchor in accordance with NFPA 30.

    a. Consider tank weight, weight of earth above tank, weight of concrete and tank buoyancy in computation for sizing concrete hold down pad.
    b. Thickness and construction of reinforced concrete pad and concrete ballast pad under fuel storage tanks which must be used to keep empty tanks from floating must be determined by the structural engineer.

4. Attach turbine enclosure to tanks at containment collar, which must be connected using Turbine Enclosure Adhesive Kit.

3.3 FIBERGLASS/HDPE PIPING

A. See Division 31 Section on earth moving for trenching and backfilling of piping on the site. The following pipe installation specific requirements also apply:

1. Use shortest practical route, minimize bends, and run all pipe in single trench from remote fuel fill points to storage tanks, from storage tanks to final fuel destination, and from storage tanks to vent risers. Pipes must run parallel to tanks and dispensers. Avoid piping across tanks.
2. Typically, piping must slope at least 1 cm for every 96 cm toward tank. Pipe must be properly supported to prevent traps or sumps.
3. Piping must be separated by distance of at least 102 to 152 mm. Trench wall must be separated by at least six 152 mm. Follow manufacture specific instructions for distances between piping, walls, bottom of trench bed thickness, and backfill heights. In all cases, pipe must be completely surrounded with select backfill of either sand or 3 to 19 mm diameter pea gravel.
4. Compact backfill carefully over and around piping system. When using tamping equipment, take care to prevent vibration from driving small stones into pipe wall. Take care to remove frozen lumps from all backfill materials before backfilling.
5. Timing: Cover pipe as soon as possible after successful testing to eliminate chance of damage to pipe, floating of pipe due to flooding, or shifting of line due to cave-ins. If damage is suspected, retest lines.

6. Run piping outside buildings underground below frost line and carefully grade to drain toward fuel storage tanks.
7. Installation: Design containment fittings dimensionally such that they can be installed adjacent to each other and not require more distance between primary fittings than necessary in non-contained installations.
8. Preparation: Containment system must be plain end by plan end when installing two piece clam fittings for FRP systems or electro fusion joints for UPP systems. Light sand or scarf bonding surfaces. No tools must be required for installation to alter pipe diameter.
9. Pipe fittings must be free from all defects including delaminations, indentations, pinholes, foreign inclusions, bubbles and resin-starved areas which, due to their nature, degree or extent, detrimentally affect strength and serviceability of pipe or fittings. Pipe and fittings must be as uniform as commercially practicable in color, opacity, density and other physical properties.
10. Extend pipes up to grade from tanks for stick gauging and manual filling, and fit with watertight, lock-type, hinged cap. Provide pad lock and two keys through Project Director/COR to Post's Security Officer.
11. Run tank vent pipe up from grade for at least 3.7 m and 1.6 m from building openings, and terminate with return bend, bronze insect screen or vandal proof weather cap. Minimum size of vent piping must be DN50.
12. Underground piping must have secondary containment test ports at all low points in piping system and at transition sump when entering building.

3.4 STEEL PIPING

A. Fuel supply piping must extend inside tanks to within 102 mm of tank bottom. Install horizontal swing check valve on each fuel supply pipe at tanks in access manhole.

B. Install steel piping from fuel fill panel to transition sump, and within buildings from transition sump to equipment within buildings.

C. Fuel oil suction piping to equipment must not be smaller than DN20, but may be reduced to size of tapping in apparatus as close as possible to apparatus. Fuel return piping must be same size as fuel supply piping.

D. Install piping with ground joint unions near each piece of apparatus to facilitate disconnecting and similar activity. Run piping inside buildings as indicated on Drawings or as directed by Project Director/COR. All pipes must be free from vibration. Ream ends of pipes out before they are screwed into fittings. At screwed joints, apply suitable lubricant to male threads only.

3.5 FILL PANEL INSTALLATION

A. Coordinate construction of perimeter walls for locations of alarm conduit, fills supply pipe discharge, and drain line. Locate fill pipe connection maximum of 1 meter above exterior grade where fueling vehicle will be parked.

B. Mount remote alarm panel in remote fill-point secure compartment.

3.6 TRANSITION SUMPS

A. Install transition sumps on secure side of fill panels where steel piping enters ground and transitions to double wall piping and install at entrances to buildings where lowest floor of building is at grade. Use entry fittings where piping leaves transition sump underground.

3.7 INITIAL FUEL OIL SUPPLY

A. Contractor must initially fill each fuel storage tank with fuel to full capacity. Contractor must supply fuel required for testing and operating equipment as required until fuel system is accepted by the Government with issuance of substantial completion, at which time full tank of fuel must be present in storage tank.

3.8 FIELD QUALITY CONTROL

A. Hydraulically field-test all steel piping to 150 percent of maximum anticipated pressure of system, or pneumatically field-test to 110 percent of maximum of anticipated pressure of system, but not less than 35-kPa gage at highest point of system. Maintain test for at least 10 minutes, or for as long as necessary to visually inspect all joints and connections on piping.

B. Pressure test both primary and containment piping systems in accordance with Piping Manufacturer’s instructions. During testing, care must be taken to avoid sudden pressure surges or "water hammer" since pressures produced can exceed, many times over, rating of pipe and fittings.

1. Inspection: Prior to testing, containment piping system installation must be completely accessible for visual inspection of primary piping system. All primary fittings, joins and pipe lengths must be visible during testing. System installation must be inspected and approved by piping supplier or it's certified contractor.

C. After installation and prior to backfilling, pressure test tank to demonstrate tightness at 35-kPa pressure. Following test, tamp backfill material thoroughly in courses of 300 mm with care exercised to avoid damage to tank. Perform backfill in accordance with directions from manufacturer in installation manual. No foreign material (e.g., broken bricks, cinder blocks) are permitted in backfill. Screen native soil in excess of DN25 from backfill material to prevent damage to tanks during backfill. Backfill must not contain large quantities of ash and cinders.

1. Inspection: Prior to testing, storage tank system installation must be inspected and approved by storage tank system supplier or its certified contractor.

D. Containment system must be able to be tested, when installed and at later times, in accordance with local regulations and EPA requirements. No metallic components must be used to maintain the integrity of the system.

3.9 START-UP SERVICE

A. Engage manufacturer's factory certified technician to perform start-up service. Start-up service must be provided for Fuel Oil System (including liquid level controls, leak monitoring controls, and fuel pump controls). Notify Project Director/COR 14 days in advance of performing startup field testing.

1. Inspect field-assembled components, equipment installation, piping, and electrical connections for proper assemblies, installations, and connection.
2. Complete installation and perform start-up check according to manufacturer's written instructions.
3. Verify that installation complies with Construction Documents.

3.10 DEMONSTRATION

A. General:

1. Training must be performed at project site. Schedule training with Project Director/COR with at least fourteen days advance notice.
2. Train Government maintenance personnel on procedures and schedules for starting and stopping, operating, troubleshooting, servicing, and maintaining equipment and schedules.
3. Review data in manufacturer supplied maintenance manuals, and site-specific operations and maintenance plan,

B. Fuel Oil System:

1. Minimum of eight hours on-site training, provided by supplier of fuel oil system controls, for operators and managers of fuel storage system.

   a. Review system monitoring and controls.
   b. Review content of Storage Tank Management Plan.
   c. Review tank filling procedures, including spill prevention and control plan.

END OF SECTION 335005

SECTION 335217 - MOTOR VEHICLE FUEL DISPENSING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide vehicular fuel dispensing equipment.

B. Related Sections include the following:

1. Section 335617 “Underground Fuel Storage Tanks and Distribution.”

1.2 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA) 30: Flammable and Combustible Liquids Code and NFPA 31: Standard for the Installation of Oil Burning Equipment.

1.3 SYSTEM REQUIREMENTS

A. Fuel dispensing equipment must conform to Chapter 13 of the OBO-ICS IMC (International Mechanical Code as amended by OBO).

1.4 SUBMITTALS

A. Product Data: For the following:

1. Vehicular fuel dispensers and fuel management system.

B. Shop Drawings: Submit shop drawings for the following:

1. Dispensers: Include elevation view of dispenser and dispenser containment sump. Identify all component connections, including for piping, power, and monitoring.
2. Fuel Management System: Include details for fuel island terminal with pump control terminal, and wiring diagram for dispenser pump controls and monitoring system.

C. Qualification Data: For manufacturer and installer.

D. Field Report: For start-up service recording inspections and results of tests.

E. Installation Instructions and Checklists: Include Manufacturer’s installation instructions for fuel dispensers and fuel management system.

F. Maintenance Data: For vehicular fuel dispensing system, include list showing recommended maintenance frequency for system components.

1. Provide spare parts lists required for each element of fuel system.

1.5 QUALITY ASSURANCE

A. Basis of Design: This Section identifies “Basis of Design” for various equipment and components. Other products from the identified manufacturer or other manufacturers are acceptable which conform to requirements of this Section.

B. Comply with the OBO-ICS NEC (NFPA 70, “National Electrical Code” as amended by OBO).

C. Listing and Labeling: Provide voltage regulators specified in this Section that are listed and labeled. Terms "Listed" and "Labeled" must be as defined in Article 100 of NFPA 70. Listing and Labeling Agency Qualifications: "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

1. Vehicle Fuel Dispensers:

a. Dispenser Sump: UL Listed.
b. Electronic Fuel Management System: UL Listed, with manufacture conducted in prescribed manner within conditions controlled by ISO (9001) Certified Quality System.

D. Manufacturer Qualifications: Manufacturers must have produced similar systems for at least the past ten years.

E. Installer Qualifications: Installers who have been trained and certified by manufacturer for installation of systems required for this project.

1.6 WARRANTY

A. General: Manufacturer’s standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

B. Electronic Fuel Management System for Vehicular Fuel Dispensing:

1. Warrant functionality of read/write keys. Provide technical support via telephone for diagnostics and assistance.

a. Warranty Period: Five years from Substantial Completion.

1.7 MAINTENANCE SERVICE

A. Commencing at the contract’s Substantial Completion date for a period of one calendar year with a renewable option for an additional year, provide proposal for system maintenance service based on manufacturer's recommended daily, weekly, quarterly, semi-annual, and annual maintenance

activities. The proposal must be submitted to the COR/Project Director at least 120 days prior to Substantial Completion.

B. The proposal must be inclusive of fuel dispensing equipment using factory-trained personnel.

PART 2 - PRODUCTS

2.1 VEHICULAR FUEL DISPENSERS

A. Basis of design: Basis is one of the following from Bennett Fleetmaster based upon product and hose indicated on Drawings:

1. Single Product, Single Hose: 3111SNR-68 UL listed remote dispenser.
2. Single Product, Dual Hoses: 3112SNS-21.
3. Dual Product, Dual Hoses: 3122SRR-27.

B. Description: Fuel dispenser for commercial and industrial applications, ready to operate with card and key-lock systems.

C. Features:

1. Electronic Totalizer; 7,571,000 liters.
2. Pumping Unit with Vortex Air Eliminator: 14 GPM nominal flow rate, 1/3 HP intermittent duty motor, 115/230V, 60/50 Hz.
3. Four-piston meter.
4. Electric and manual resets.
5. 25 mm (1 inch) diameter hose outlet with reducer, 19 mm (¾ inch) by 3.7 m (12 foot) long hose.
6. Sturdy hose hanger hook.
7. Field wiring terminal strip in ballast box.
8. Clear acrylic dial face inserts.
9. Brushed stainless steel top and sides.
10. White dial face covers.
11. Lighted dial face.
12. Stainless steel lower doors.
13. Internal 10:1 gallon pulser.
14. Satellite internal pipe connection.
15. Field installed hose retriever.
16. Diesel Fuel Nozzle: OPW 11A, or approved equal, 19 mm by 19 mm (¾ inch by ¾ inch) swivel.
17. Unleaded Fuel Vapor Recovery Type Nozzle:

    a. Basis of Design: Heally 800-02G3FS with 18 mm by 19 mm (3/4 inch by ¾ inch) swivel.

18. Hose Breakaway: OPW #66 with 230 mm (9 inch) whip hose, or approved equal.

19. Safety Valve: EBW 38 mm (1½ inch) double poppet or approved equal. Cast iron zinc-plated body and adapter; UL listed, conforms to NFPA 30A. Valve must automatically shut-off in event of a fire or impact.
20. Provide FRP dispenser sump with stabilizer bars, 762 to 1067 mm depth as required.

    a. Basis of Design: OPW-FCS dispenser sump.

21. Provide "emergency stop" button to facilitate immediate termination of fueling in case of emergency.

2.2 ELECTRONIC FUEL MANAGEMENT SYSTEM FOR VEHICULAR FUEL DISPENSING

A. Basis Of Design, subject to compliance with requirements of this Section:

1. Petro Vend System2, with Chipkey Option.
2. Syntech-Fuelmaster with key activation.

B. General:

1. Manufacture system using current microprocessor technology.
2. Design system to offer wide variety of operational modes and to provide maximum versatility without special programming or engineering changes. Provide ease and economy of expansion.
3. System must be capable of operating as stand-alone fuel management system. It must have capacity of interfacing with variety of data processing equipment. Data processing equipment may be located on-site or remotely. In remote mode, all commands and functions normally performed on-site through local data terminal must be executable remotely.
4. System must also comply with local standards where applicable, as well as applicable Federal Communications Commission (FCC) requirements.
5. System must provide self-test and diagnostic utilities for start-up and troubleshooting.

C. System Overview:

1. Purpose of system is to control dispensing equipment and provide accurate accounting of all fuel and related products being dispensed.
2. System must record data for each transaction in non-volatile memory and on journal printer.
3. System must have capability of user access by one of the following: Magnetic stripe card, hole-punched (optically coded) card, multi-programmable memory key, and manual entry of numbers via keyboard.

    a. References to cards or card users in this Section must be interpreted to include any of these listed access methods.

4. Access to products must be restricted to people holding valid cards and who perform predetermined series of data entry operations.
5. Internal electronic file must hold data for each card.

6. Authorized operator must be able to check and change system operating parameters, as well as card and account data.
7. All system commands must be menu-driven with on-screen "help" support for explanation of all functions. Single line command mode should also be available.

D. System Components:

1. Contain fuel island terminal (FIT) in weatherproof cabinet. Provide pedestal for mounting FIT. FIT must include the following features:

   a. Easy-to-read, back-lit, 2 line x 16 character, alphanumeric liquid crystal display (LCD).

      1) Display must be readable in bright sunlight.
      2) System must also be capable of being optionally equipped with 75 mm x 125 mm (3 inch x 5 inch) backlit graphic liquid crystal display (LCD).
      3) I line x 40 character display must also be available.

   b. 12-key metal keyboard with audible (tone) and tactile (keys move when pressed) feedback.
   c. "Emergency stop" button to facilitate immediate termination of fueling in case of emergency.
   d. Each Fuel Island Terminal (FIT) must be able to house up to 8 relays (1 per hose). Each FIT must be able to selectively access up to 32 hoses controlled by other FITS.
   e. Fuel Island Terminal (FIT) must have capability of being equipped with 2 different card/key reading devices to facilitate combination of cards and keys. Any combination of the following devices must be available:

      1) Push/pull magnetic card reader.
      2) Motorized magnetic card reader.
      3) Optical card (hole-punched) reader.
      4) Multi-programmable read/write key reader.

   f. Fuel Island Terminal (FIT) must be capable of being equipped with internal receipt printer. Receipt printer must use plain paper and have integral paper cutter.

2. Fuel Site Controller (FSC) must have capacity to connect up to 4 FIT units. Fully expanded system must be able to control 32 hoses simultaneously. Both mechanical and electronic pumps must be controllable by system.
3. Communication protocol between FSC and the FIT's must be RS485. Maximum wiring distance between the FSC and any FIT must be 5000 feet.
4. System must have two RS/232 ports for communication. One must be used to directly interface to an ASCII terminal, personal computer, or mainframe computer, which is capable of performing ASCII communication. One of these devices must be required to configure the system and generate reports.
5. System must have 5 x 9 pin dot-matrix bi-directional journal printer which must be located near FSC to make hard copies of transaction data and reports. Printer must be capable of operating at 180 cps (characters per second). Printer must use standard 216 mm x 280 mm

(8 1/2 inch x 11 inch) pin-feed paper and be capable of printing on 1, 2, or 3 part paper. System must be capable of operation with or without journal printer.

E. System Capabilities and Features:

1. Card/Key File Memory: System's memory must be flexible to maximize amount of card records and transaction records that can be stored, based on data stored for each card record. System must allow operator to determine what data is stored for each card record. There must be 3 incremental memory upgrades to increase amount of storage from standard configuration of 256 Kbytes to maximum of 2 Megabytes. Table 2.2 indicates typical ranges for card record and transaction record storage for each of memory configurations:

TABLE 2.2
CARD/KEY FILE MEMORY

MEMORY SIZE	NO. OF TRANSACTIONS	NO. OF CARDS MIN. DATA/CARD	NO. OF CARDS MAX. DATA/CARD
256 K	100	11,197	3,149
	1,000	6,397	1,799
512 K	100	25,761	7,245
	2,000	12,961	3,645
1 MB	100	54,888	15,437
	5,000	28,754	8,087
2 MB	100	113,142	31,821
	10,000	60,342	16,991

2. System must be capable of storing the following data for each card record:

a. Card/Key Number: 19 digits.
b. Card/Key Type: Single, Driver, Vehicle.
c. Status: Valid or Invalid.
d. Account Number: O - 9999.
e. Expiration Date: NW/DD/YY.
f. Monthly Allocation: $NNNNNN.NN.
g. Daily Allocation: $NNNNNN.NN.
h. Misc. Keyboard Entry: Off/On.
i. Personal Identification Number (PIN): O - 6 digits.
j. Current Odometer: 6 digits.
k. Odometer Reasonability Code: Up to 15 different levels.
l. Pump Restriction: Up to 15 different levels.
m. Quantity Restriction Level: Up to 15 different levels.
n. Driver Name: 9 characters.
o. Language Code: 1 digit.
p. Warning Odometer: 6 digits.

q. No Fuel Odometer: 6 digits.
r. Daily Limit: 1 digit.
s. Upper and Lower Range: 2 digits, 4 total.
t. Method: 1 digit.
u. Card Medium and ChipKey Modification Flags: 8 digits.

3. Account File Memory: System must have capacity to store 10,000 account records. Each record must contain:

a. Account Number: O - 9999.
b. Status: Valid or Invalid.
c. Account Discount: O - 99 percent.
d. Expiration Date: MMOD/YY.
e. Monthly Allocation: $NNNNNN.NN.
f. Daily Allocation: $NNNNNN.NN.
g. Quantity Restriction Level: Up to 15 different levels.
h. Pump Restriction: Up to 15 different levels.
i. Account Name: 9 characters.

4. Transaction Memory: System must have capacity to store transactions in non-volatile RAM. See Table 2.10, “Card/Key File Memory” for capacities. Each transaction must contain:

a. Sequential Transaction Number.
b. Transaction Termination Code (e.g., Normal, Quantity Restriction).
c. Account Name.
d. Driver Card Number.
e. Vehicle Card Number (omitted for single card transactions).
f. Date and Time.
g. Fuel Type.
h. Pump Number.
i. Quantity Dispensed.
j. Unit Price.
k. Total Transaction Extended Monetary Amount.
l. Odometer Entry.
m. Misc. Keyboard Number.
n. Consumption Factor: Miles per Gallon or Liters/100km.
o. Receipt Status: Issued/Not Issued.

5. Fuel Type (Product) Identification: Operator must be able to specify and store price and description of up to 16 products.
6. Miscellaneous Entry Field Capacity: System must be capable of recording a field of up to 10 digits entered at keyboard by user.
7. Clock/Calendar: System must keep accurate accounting time and date, even in event of power failure. Date and time formats must be user selectable (i.e., 12/24 hr, MMM/DD or DD/MMM). System must be able to automatically correct for daylight savings time.

8. Fuel Type Restriction: Operator must be able create table of up to 15 combinations, or levels, of authorized products. Operator must then be able to assign level number to each individual user or account group.
9. Quantity Restriction: Operator must be able to create a table of 15 quantity restriction levels. Operator must then be able to assign level number to each individual user or account group to limit amount of fuel dispensed for each transaction. Restriction must be by either quantity or monetary value.
10. Open/Close: System must have capability of being placed in either "Open" or "Closed" mode by authorized personnel. Fueling must not be allowed in "Closed" mode.
11. Single or Dual Card/Key Operation: Operator must be able to program system for cardless (manual entry via keyboard), single and/or dual card/key operation.
12. Personal Identification Numbers (PIN): System must have ability to recognize and verify up to 6-digit Personal Identification Number (PIN) when entered at Fuel Island Terminal. The system must be able to invalidate a card after 3 consecutive incorrect PIN entries. Operator must have choice of methods to select PIN's for each individual user:

    a. Individually program PIN number for each user.
    b. Automatically generate random PIN number.

13. Pump Configuration: Operator must be able to program and store up to 32 operating parameters for each hose position. These parameters must include:

    a. Pump Number: A pump number from 0 - 99 to be assigned to any available relay position.
    b. Fuel Type Number: Fuel Type number (1 - 16) and operator-selectable description of product being dispensed by pump.
    c. Tank Number: Tank number (1 - 8) to be used by inventory program.
    d. Quantity of Fuel per Transaction Limit.
    e. Total Transaction Time-Out: System must be able to monitor total transaction time, programmable for each hose between 1 - 999 seconds (entry of 'O' must allow unlimited time). System must turn off the pump if that time is exceeded.
    f. Pump Handle Time-Out: System must monitor time between authorization and activation of pump handle, which is programmable for each hose between I - 999 seconds (entry of 'O' must allow unlimited time). If device is selected but pump handle not activated by user before end of this period, transaction must be terminated.
    g. First Pulse Time-Out: System must monitor time between activation of pump handle and receipt of first pulse, which is programmable for each hose between I - 999 seconds (entry of 'O' must allow unlimited time). Transaction must be terminated if that time exceeds programmed parameter.
    h. Missing Pulse Detector (MPD) Time-Out: Missing Pulse Detector" (MPD) must be built into circuit controlling each pump so that all power must be removed from pump if pulses indicating fuel flow are not received at regular intervals. Length of acceptable interval between pulses must be 'programmable for each hose between 1 - 999 seconds (entry of 'O' must allow unlimited time).
    i. Pulser Divide Rate: Operator must be able to program system to assign 1 - 9999 pulses per unit of fuel measure.

j. Pump Deactivation Sentry: Operator must be able to program the system to automatically place pump "out of service" after 3 consecutive "zero quantity" fueling transactions occurring from that pump (zero quantity transactions may be indication of pump or pulser hardware failure). "Out of service", or other operator defined message, pump must be indicated on Fuel Island Terminal (FIT) display. System must have flexibility to disable this function for one or more particular pumps.
k. Messaging: System must have capability of displaying up to 100 different, operator-defined messages at Fuel Island Terminal (and printed on receipt) for specific Card/Key or Account numbers. System must have capability to automatically clear messages after operator-determined time period.

14. Card/Key Status: System must have capacity to allow driver and vehicle cards/keys to be declared valid or invalid by authorized personnel.
15. Site Name: System must have provision to program 12 character site name into memory. This is used when system is accessed by modem.
16. Pump and Product Totals: System must have capacity to accumulate individual pump and product totals as well as track each pump totalizer. Operator must be able to enter initial pump totalizer number into system for each pump. This number will be incremented by system when product is dispensed and can be checked against pump's totalizer to determine accuracy and working status of pulser.
17. Inventory Control: Operator must be able to program into system memory up to 8 tank inventory balances. Inventory balance for each product must be reduced automatically as each fueling transaction occurs. Operator must be able to change this number to accommodate fuel deliveries. System must be capable of 'displaying, on demand, current inventory amount for each individual tank.
18. Manual Operation: Operator must have ability to place pumps in "manual" mode, allowing manual operation of pumps (without entering rare ID). This must be done directly through programming terminal, or remotely by modem.
19. Display Prompts: Fuel Island Terminal display prompts must be programmable by operator. System must use set of standard default prompts at start-up.
20. Dual Language: System must have capability of storing 2 sets of Fuel Island Terminal (FIT) display messages in 2 different languages or 2 separate sets of display prompts (e.g., “Enter Odom” as opposed to “Enter Hubmeter”). When card/key is read, system must display all messages in correct language for that user.
21. Password: Operator must be able to program a 6-character, alphanumeric password that must be entered correctly to gain access to system either directly or via phone.
22. Pump Handle Monitor: System must monitor the pump handle to ensure that it was turned to "OFF" (reset) position before pump can be reactivated. Operator must be able to disable this feature.
23. Pass-through Communications Port: System must have capability of passing modem communications through to another RS/232 device.
24. Memory Key Report Features: Memory Key must:

    a. Be read/write device.
    b. Be made of highly durable plastic, able to withstand daily usage and handling.
    c. Be static-resistant.
    d. Have several methods of responding to incorrect odometer or hour readings.
    e. Have ability to be coded for minimum odometer or hour entry.

f. Have ability to be coded for maximum odometer or hour entry.
g. Have ability to be encoded a minimum of 10,000 times.
h. Contain last correct odometer entry and must have ability to download odometer entry to any key reader.
i. Have ability to be programmed with warning odometer for servicing purposes.
j. Have ability for "no fuel" odometer to prevent vehicle from not being serviced.

25. Memory Key with Multi-Site Odometer Reasonability: System must have capability of storing last odometer reading into memory key. Using stored reading, system must determine if current entry is "reasonable" (within specified range) before allowing access to fuel. Memory Key must also log number of unreasonable odometer entries and number of transactions per day. System must also have ability to prompt fuelers with service warnings and to prevent fueling when odometer entries meet or exceed programmed levels. System must check for lower and upper value for odometer reasonability range. System must allow for 5 different methods of odometer response to three sequential incorrect entries. If two or three bad odometer entries are same, current odometer entry must be printed in odometer field and odometer value in Memory Key must be updated. Bad entry counter must be automatically reset to zero after good odometer entry.

a. Method 0: Method 0 must be "bypass". All odometer entries are defined by system as reasonable. Fueling must always be allowed.
b. Method 1: This must be most restrictive method. After three bad odometer entries, Memory Key must be invalidated and fueling disallowed for user. System must not recognize invalidated Memory Key until it is reset (reprogrammed).
c. Method 2: Second method must log unreasonable odometer entries in same ways as Method 1. After third bad entry, Memory Key must be flagged on report and on transaction receipt by printing '< < <' in odometer field. Fueling must be allowed but only for entire current transaction.
d. Method 3: Method 3 must always allow fueling, and bad entries must be logged in two ways. If all three bad entries are different, transaction is flagged on transaction receipt and on report by printing '===' in odometer field. Odometer reading stored in Memory Key must not be updated, but bad entry log in Memory Key must be reset to zero. User must enter three more bad odometer readings for his transaction to be flagged again. If two or three of bad entries are same, '> > >' must be printed in odometer field and odometer value in Memory Key must be updated.
e. Method 4: Method 4 must log bad entries in two ways. Fueling must always be allowed. If all three bad entries are different, transaction must be flagged on transaction receipt and on report by printing '= = =' in odometer field. Odometer reading stored in Memory Key must not be updated, but bad entry log in Memory Key must be reset to zero. User must be required to enter three or more bad readings for his transaction to be flagged again.

26. Account Group Discount: System must have capability to assign discount, either in percent (O - 99 percent) or in cents per gallon/liter to each account. That discount must be reflected on price of each transaction.
27. Memory Key Encoding Method: FIT must be able to encode Memory Key in 2 methods.

a. Method 1: By authorized user placing FIT into manual encoding mode. This mode utilizes keyboard to program all or any of Memory Key fields.
b. Method 2: FIT must be able to automatically reprogram Memory Key (with on-site or remotely downloaded data) when key is inserted (e.g., new time for service or warning odometer message).

F. Vehicular Fuel Dispensing System Reporting:

1. System must have capability to generate reports. Operator must be able to access these reports on-demand via data terminal. System must be able to display or print report data at user's discretion.
2. System Information Reports:

a. System Status Report
b. Fuel Island Terminal (FIT) Status
c. Pump Configuration Data
d. Transaction Data Report
e. Card/Key Information Report
f. Account Information Report
g. Pump Totals and Totalizers Report
h. Inventory Report
i. Product Totals Report

PART 3 - EXECUTION

3.1 GENERAL

A. Install dispensing equipment, including accessories as indicated on Drawings.

1. Verify location of equipment conforms to requirements of Chapter 13 of the OBO-ICS IMC.
2. Install wiring in conduit with long radius bends at all changes in direction. Comply with Division 26 requirements for conduit.

3.2 VEHICULAR FUEL DISPENSERS INSTALLATION

A. A.Install Fuel dispensers with dispenser sumps according to manufacturer's written instructions.

3.3 ELECTRONIC FUEL MANAGEMENT SYSTEM INSTALLATION FOR VEHICULAR FUEL

A. Fuel Island Terminal: Install fuel island terminal system in accordance with manufacturer’s installation details.

B. Install Electronic fuel Management System in accordance with manufacturer's written instructions.

3.4 START-UP SERVICE

A. Engage manufacturer’s factory certified technician to perform start-up service. Start-up service must be provided for Electronic Fuel Management Systems (for vehicular fuel dispensing). Notify Project Director/COR 14 days in advance of performing startup field testing.

1. Inspect field-assembled components and electrical connections for proper assemblies, installations, and connection.
2. Complete installation and perform start-up check according to manufacturer’s written instructions.
3. Verify that installation complies with Construction Documents.

3.5 DEMONSTRATION

A. General:

1. Training must be performed at project site. Schedule training with Project Director/COR with at least fourteen days advance notice.
2. Train Government maintenance personnel on procedures and schedules for starting and stopping, operating, troubleshooting, servicing, and maintaining equipment and schedules.
3. Review data in manufacturer supplied maintenance manuals, and site-specific operations and maintenance plan,

B. Electronic Fuel Management System for Vehicular Fuel Dispensing:

1. Minimum of eight hours of on-site training, provided by fuel management system supplier, for operators and supervisors of fuel island management units and related software.

a. Review system controls.
b. Provide minimum of four additional hours training for users of software system, either on-site or online. Review use and maintenance of system software.

END OF SECTION 335217

SECTION 337105 - UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Ducts in direct-buried duct banks.
2. Ducts in concrete-encased duct banks.
3. Handholes and handhole accessories.
4. Manholes and manhole accessories.
5. Locking devices for handholes, manholes and other devices provided to allow access to power and signal wiring for security devices (i.e., vehicle barriers, cameras, TSS equipment).

B. Related Sections include the following:

1. Section 033000 “Cast-in-Place Concrete,” including but not limited to provisions for field conditions, materials, and installation.
2. Section 260518 “Low-Voltage Electrical Power Conductors and Cables.”
3. Section 260525 "Grounding and Bonding for Electrical Systems" for grounding electrodes, counterpoise conductors, clamps and connectors for grounding metallic manhole and handhole accessories and testing of grounds.
4. Division 26 Section on “Raceways and Boxes.”
5. Section 270526 “Grounding and Bonding for Communications Systems.”
6. Division 27 Sections on communications.
7. Section 28 Sections on technical security systems and fire alarm systems.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Manhole and handhole hardware.
2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
3. Duct-bank materials, including spacers and miscellaneous components.
4. Warning tape.
5. Locking devices.

B. Shop Drawings: For cast-in-place and precast manholes and handles, submit shop drawings showing construction/fabrication and installation details for the items below. Precast elements must have shop drawings signed and sealed by qualified professional engineer.

1. For cast-in-place manholes and handholes:

a. Duct sizes and locations of duct entries.

b. Reinforcement details for cast-in-place structures.
c. Manhole cover design.
d. Step details.
e. Grounding details.
f. Dimensioned locations of cable rack inserts, pulling-in irons.
g. Locking devices.

C. Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale and show all bends and location of expansion fittings.

D. Splice Documentation: Document location and installation of splices for work in this Section. Documentation must be by trained splice technician that performed work.

E. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.

F. Product Test Reports: Indicate compliance of precast manholes with ASTM C 857 and ASTM C 858, based on factory inspection.

G. Thermal Imaging Report: Documentation of imaging; see the Article on FIELD QUALITY CONTROL.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories (Including Ducts for Communications and Telephone Service) Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with the OBO-ICS NEC (OBO Electrical Code) and OBO-ICS IZC (OBO Zoning Code).

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.5 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by Project Director/COR.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Conduit and fittings are specified in Division 26 Section on "Raceways and Boxes."

2.2 DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 HANDHOLES

A. Cast-in-Place or Precast: Fabricate according to requirements for cast-in-place handholes in the Article on UNDERGROUND ENCLOSURE APPLICATION.

2.4 MANHOLES

A. Cast-in-place or precast enclosures.

B. Precast Units:

1. ASTM 478, with interlocking mating sections, complete with accessories, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
2. Design and fabricate structure according to ASTM C 858.
3. Design structure according to details on Drawings.
4. Source Quality Control: Inspect structures according to ASTM C 1037.

C. Steps: Individual FRP or Steel Reinforced Polypropylene steps, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 300 mm- to 400-mm (12 Inch- to 16-inch) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 1200mm (48 Inches).

2.5 ACCESSORIES

A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.

B. Manhole Frames and Covers: Comply with AASHTO loading specified for manhole.

1. Provide cast covers with cast-in legend as applicable:

a. "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
b. "ELECTRIC-HV" for duct systems with medium-voltage cables.
c. "SIGNAL" for communications, data, and telephone duct systems.

2. Cast iron with cast-in legend "ELECTRIC" as indicated. Milled cover-to-frame bearing surfaces.
3. Manhole Frames and Covers: ASTM A 48; Class 30B gray iron, 762 mm size, machine-finished with flat bearing surfaces.
4. Special Covers: Recess on cover designed to accept finish material in paved areas.

C. Handhole Frames and Covers: Provide cast covers with cast-in legend:

a. "ELECTRIC."

D. Cover Lock Bolts: At office compounds, provide bolts for all manhole and handhole covers.

E. **Locking manhole covers:** Provide bolts with unique patterned heads designed for manholes. (typically for TSS equipment and wiring or fuel lines) Acceptable manufacturers are:
F. Van Lock
G. McGard
H. Other approved equal subsittutions must be submitted for DOS reivew and acceptance.

I. **Tamper resistant manhole covers:** Provide penta or 5-sided bolt heads designed for exterior manholes (typically for electrical and communication).

J. Sump Frame and Grate: ASTM A 48, Class 30B gray cast iron.

K. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 50 mm diameter eye and 25-by-100-mm bolt.

1. Working Load Embedded in 150 mm, 25 MPa Concrete: 60 kN minimum tension.

L. Pulling and Lifting Irons in Floor: 22 mm diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.

1. Ultimate Yield Strength: 180 kN shear and 270 kN tension.

M. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 13 mm ID by 70 mm deep, flared to 30 mm minimum at base.

1. Tested Ultimate Pullout Strength: 53 kN minimum.

N. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 12 mm bolt, 24 kN rated pullout strength, and minimum 30 kN rated shear strength.

O. Cable Stanchions: Heavy duty PVC; punched with 14 holes on 40 mm centers for cable-arm attachment.

P. Cable Arms: 5 mm thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 300 mm wide by 350 mm long and arranged for secure mounting in horizontal position at any location on cable stanchions.

Q. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

R. Grounding Materials: Comply with Section 260525 "Grounding and Bonding for Electrical Systems."

S. Ladder: Fiberglass specifically designed for electrical manhole use. Minimum length equal to distance from deepest manhole floor to grade plus 900 mm.

T. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 2 deg C. Capable of withstanding temperature of 150 deg C without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

U. Warning Tape: Underground-line warning tape specified in Division 26 Section on "Identification for Electrical Systems."

2.6 CONSTRUCTION MATERIALS

A. Waterproofing: Comply with Division 07 Sections.

B. Mortar: Comply with ASTM C 270, Type M, except for quantities less than 60 L where packaged mix complying with ASTM C 387, Type M, may be used.

C. Concrete: Use 25 MPa minimum, 28-day compressive strength and 10-mm maximum aggregate size. Concrete and reinforcement are specified in Section 033000 "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct bank, manholes, and handholes with final arrangement of other utilities, site grading, and surface features in accordance with Drawings and as determined in the field. Notify Project Director/COR if there is a conflict between areas of excavation and existing structures identified to remain, vegetation identified to remain (e.g,, trees), or archaeological sites.

B. Coordinate elevations of duct-bank entrances into manholes, and handholes with final locations and profiles of duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct bank will drain to manholes and handholes, and as approved by Project Director/COR.

C. Clear and grub vegetation to be removed, protect vegetation to remain, and remove and stockpile topsoil for reapplication according to Drawings or other Specification Sections.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Sections for earthwork and backfill but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections for landscaping.

D. Restore disturbed pavement. Refer to Division 01 Sections for cutting and patching for additional information for this Section.

3.3 CORROSION PROTECTION

A. Corrosion protection must conform to OBO-ICS NEC Chapter 1 and OBO-ICS IBC Appdx R.

B. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

C. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 UNDERGROUND DUCT APPLICATION

A. Underground Ducts for Electrical Cables Higher Than 600 V: Type EPC-80-PVC, concrete-encased duct bank.

B. Underground Ducts for Electrical Feeders 600 V and Less: Type EPC-40-PVC, concrete-encased duct bank.

C. Underground Ducts for Communications Utility Service: Type EPC-40-PVC, concrete encased duct bank, except use Type EPC-80-PVC when crossing roads.

D. Underground Ducts for Communication Circuits: Type EPC-40-PVC, concrete encased duct bank.

3.5 UNDERGROUND ENCLOSURE APPLICATION

A. Loading Design: Reference standard identified below identifies the Basis-of-Design utilizing precast concrete enclosures unless noted otherwise. Cast-in-place enclosures must be designed for equivalent loading.

1. Handholes and Boxes for 600 V and Less:

a. Units in Roadways and Other Deliberate Traffic Paths: H-20 structural load rating according to AASHTO HB 17.
b. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: H-20 structural load rating according to AASHTO HB17.
c. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: H-10 structural load rating according to AASHTO HB17.
d. Units Subject to Light-Duty Pedestrian Traffic Only: Cast-in-place with structural loading to 20 MPa (3000 psi).
e. Cover design load must not exceed the design load of the handhole or box.

2. Manholes:

a. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
b. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB17.

B. Cast-in-Place Manhole and Handhole Construction:

1. Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of handhole. Locate duct entrances and windows near corners to facilitate racking of cabling and conductors. Place built-in items must be installed before pouring concrete.

3.6 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius as indicated on Drawings, with no less than 7.50 m radius, both horizontally and vertically, at other locations.

C. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Manholes and Handholes: Space end bells approximately 250 mm o.c. for 125-mm ducts and vary proportionately for other duct sizes. Change from regular spacing to end-bell spacing 3 m from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

E. Building Entrances: Make a transition from underground duct to conduit at least 3 m outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

F. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 150 mm between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate

each pour in a vertical plane and install 20 mm (#6) reinforcing rod dowels extending 450 mm into concrete on both sides of joint near corners of envelope.

3. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Depth: Install top of duct bank at least 600 mm below finished grade in nontraffic areas and at least 750 mm below finished grade in vehicular traffic areas, unless otherwise indicated, or where frost depth exceeds those dimensions.

G. Warning Tape: Bury warning tape approximately 300 mm above all concrete-encased duct banks. Align tape parallel to and within 75 mm of the centerline of duct bank.

H. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 1.5 m from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 75 mm of concrete.

I. Sealing: Seal all penetrations into manholes, hand holes, and building penetrations. Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Seal around empty conduit. Use sealing compound and plugs to withstand at least 1.00 MPa (150 psi) hydrostatic pressure.

J. Identify spare ducts with stamped stainless steel tags where ducts terminate at other structures such as handholes, manholes, pullboxes, and buildings.

K. Pulling Cord: Install 450 N (100 lbf) test nylon cord in ducts, including spares.

L. Cable splices are not permitted in ductbanks or conduits; they are only permitted in manholes.

3.7 MANHOLE AND HANDHOLE INSTALLATION

A. Elevation: Install manholes with rooftop at least 375 mm below finished grade. Install handholes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 25 mm above grade.

B. Incorporate clear vertical access area to allow insertion and removal of portable pump to drain manholes and vaults prior to start of work. Cables and supports must not be located within, or intrude upon, pump access area.

C. Drainage: Install drains in bottom of units where indicated. Coordinate with drainage provisions indicated.

D. Access: Install cast-iron frame and cover at top of access. Set frames in paved areas and trafficways flush with finished grade and set other frames 25 mm above finished grade. Install accessways in one of the following manner:

1. Install brick chimney to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
2. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Racking: Rack cabling and conductors in manholes and utility trenches against walls of each. Cables and conductors are not permitted to be placed in center portion of manholes; they must be positioned to ensure safe personnel access at manhole.

F. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least three days. Apply according to Division 07 Sections for waterproofing sheet membrane, if applicable. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole and handhole chimneys after brick mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Field-Installed Bolting Anchors: Do not drill deeper than 98 mm for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

I. Cable Splices: Limit splices for work in this Section. Splices must be UL listed for applications. Splice installation must be performed and documented by trained splice technician; see the Article on SUBMITTALS. Splices must have identification tags; these must be visible in manhole where splice occurs.

J. Grounding: Install ground rod through floor in each structure with top protruding 100 mm above floor. Seal floor opening against water penetration with waterproof non-shrink grout. Ground exposed metal components and hardware with bare-copper ground conductors. Train conductors neatly around corners. Use cable clamps secured with expansion anchors to attach ground conductors.

K. Cast-in-Place Manhole Installation: Comply with applicable requirements in Section 033000 "Cast-in-Place Concrete."

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Where indicated on Drawings or otherwise required, form and pour concrete knockout panels 38 to 50 mm thick, arranged as indicated.

L. Precast Concrete Manhole Installation: Unless otherwise indicated, comply with ASTM C 891.

1. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 25-mm sieve to 4.75-mm sieve and compacted to same density as adjacent undisturbed earth.

3.8 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

B. Grounding: Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260525 "Grounding and Bonding for Electrical Systems."

C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Thermal Imaging: Upon completion of installation and full energization of system, exam all racking with thermal imaging to ensure minimal heating from Electromagnetic Interference.

E. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 337105