FEDERAL AVIATION ADMINISTRATION

MIKE MONRONEY AERONAUTICAL CENTER

Mechanical and Electrical Upgrades Headquarters Building

OKLAHOMA CITY, OKLAHOMA

Project Manual

Type B - 100% Design Submission
February 20, 2025

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TABLE OF CONTENTS

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

SECTION 000107 – SEALS PAGE
SECTION 003126 - EXISTING HAZARDOUS MATERIAL INFORMATION
SECTION 003143 - PERMIT APPLICATION
SECTION 004373 - PROPOSED SCHEDULE OF VALUES FORM

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 010100 - SUMMARY OF WORK
SECTION 010190 - CONTRACT CONSIDERATIONS
SECTION 010280 - MODIFICATION PROCEDURES
SECTION 010300 - OPTIONS
SECTION 010390 - COORDINATION AND MEETINGS
SECTION 010450 - CUTTING AND PATCHING
SECTION 012100 - ALLOWANCES
SECTION 013000 - SUBMITTALS
SECTION 014000 - QUALITY REQUIREMENTS
SECTION 015000 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
SECTION 016000 - MATERIAL AND EQUIPMENT
SECTION 016010 - SUBSTITUTIONS REQUEST FORM
SECTION 016500 - STARTING OF SYSTEMS
SECTION 017000 - CONTRACT CLOSEOUT
SECTION 017300 - OPERATION AND MAINTENANCE DATA
SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
SECTION 017900 - DEMONSTRATION AND TRAINING
SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 024119 - SELECTIVE DEMOLITION

DIVISION 03 - CONCRETE

SECTION 033000 - CAST-IN-PLACE CONCRETE

DIVISION 04 - MASONRY

SECTION 042000 - UNIT MASONRY
SECTION 047200 - CAST STONE MASONRY

DIVISION 05 - METALS

SECTION 055000 - METAL FABRICATIONS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 061000 - ROUGH CARPENTRY

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 072100 - THERMAL INSULATION
SECTION 078413 - PENETRATION FIRESTOPPING
SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS
SECTION 079200 - JOINT SEALANTS

DIVISION 08 - OPENINGS

SECTION 081416 - FLUSH WOOD DOORS
SECTION 083113 - ACCESS DOORS
SECTION 087100 - DOOR HARDWARE

DIVISION 09 - FINISHES

SECTION 092216 - NON-STRUCTURAL METAL FRAMING
SECTION 092900 - GYPSUM BOARD
SECTION 095113 - ACOUSTICAL PANEL CEILINGS
SECTION 096513 - RESILIENT BASE AND ACCESSORIES
SECTION 096813 - TILE CARPETING
SECTION 099123 - INTERIOR PAINTING

DIVISION 10 - SPECIALTIES

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

DIVISION 21 - FIRE SUPPRESSION

SECTION 211313 - WET PIPE SPRINKLER SYSTEMS

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

SECTION 230130.52 - EXISTING HVAC AIR DISTRIBUTION SYSTEM CLEANING
SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
SECTION 230523.12 - BALL VALVES FOR HVAC PIPING
SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING
SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC
SECTION 230713 - DUCT INSULATION
SECTION 230719 - HVAC PIPING INSULATION
SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC
SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC
SECTION 230923.11 - CONTROL VALVES
SECTION 231123 - FACILITY NATURAL-GAS PIPING
SECTION 232113 - HYDRONIC PIPING

SECTION 232116 - HYDRONIC PIPING SPECIALTIES
SECTION 232300 - REFRIGERANT PIPING
SECTION 233113 - METAL DUCTS
SECTION 233300 - AIR DUCT ACCESSORIES
SECTION 233600 - AIR TERMINAL UNITS
SECTION 237313.16 - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS
SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

DIVISION 26 - ELECTRICAL

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS
SECTION 260573.13 - SHORT-CIRCUIT STUDIES
SECTION 260573.16 - COORDINATION STUDIES
SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS
SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS
SECTION 260944 - LIGHTING CONTROLS
SECTION 260951 - CENTRAL INVERTER FOR EMERGENCY LIGHTING
SECTION 262200 - LOW-VOLTAGE TRANSFORMERS
SECTION 262416 - PANELBOARDS
SECTION 262726 - WIRING DEVICES
SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS
SECTION 263213.16 - GAS ENGINE-DRIVEN GENERATOR SETS
SECTION 263600 - TRANSFER SWITCHES
SECTION 263601 - GENERATOR DOCKING STATION
SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS
SECTION 265119 - LED INTERIOR LIGHTING
SECTION 265619 - LED EXTERIOR LIGHTING

DIVISION 27 - COMMUNICATIONS

SECTION 275319.13 - FIRST RESPONDER DISTRIBUTED ANTENNAE SYSTEMS (DAS)

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 321313 - CONCRETE PAVING
SECTION 321373 - CONCRETE PAVING JOINT SEALANTS
SECTION 321716 - PARKING CONTROLS

DIVISION 33 - UTILITIES

SECTION 333111 - SITE SANITARY UTILITY SEWERAGE
SECTION 334100 - STORM UTILITY DRAINAGE PIPING

DOCUMENT 000107 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:

1. Responsible for Divisions 01-14 except where indicated as prepared by other design professionals of record.

B. Fire-Protection Engineer:

1. Responsible for Division 21 except where indicated as prepared by other design professionals.

C. HVAC Engineer:

1. Responsible for Division 23 except where indicated as prepared by other design professionals of record.

D. Electrical Engineer:

1. Responsible for Divisions 26-28 except where indicated as prepared by other design professionals of record.

END OF DOCUMENT 000107

STATE OF OKLAHOMA
MICHAEL JAMES TURNER
25815
LICENSED ARCHITECT
2.20-25

OKLAHOMA CERTIFICATE OF AUTHORIZATION
ARCHITECTURE: # 00199
EXP. 06/30/2025

LICENSED PROFESSIONAL ENGINEER
JASON MARK ELLIOTT
30719
OKLAHOMA
2-20-2025

LICENSED PROFESSIONAL ENGINEER
CHRISTIAN L. FOSHEE
30767
02/20/2025
OKLAHOMA

LICENSED PROFESSIONAL ENGINEER
J.T. LITTLE JR.
20555
OKLAHOMA
2/20/2025

OKLAHOMA CERTIFICATE OF AUTHORIZATION
P.E: # 1072
EXP. 06/30/26

DOCUMENT 003126 - EXISTING HAZARDOUS MATERIAL INFORMATION

PART 1 - GENERAL

1.1 EXISTING HAZARDOUS MATERIAL INFORMATION

A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for FAA HQB MEP Upgrades. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.

B. An existing asbestos floor plan dated August 1, 2022, is available for viewing as appended to this Document.

END OF DOCUMENT - 003126

DOCUMENT 003143 - PERMIT APPLICATION

PART 1 - GENERAL

1.1 PERMIT APPLICATION INFORMATION

A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for FAA HQB MEP Upgrades. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of the Bidders' own investigations. This Document and its attachments are not part of the Contract Documents.

B. Permit Application: The building permit for Project will be applied for by Contractor. A copy of the Permit Application is attached to this Document. Contractor is responsible for picking up the permit and paying the balance of the permit fees.

END OF DOCUMENT 003143

SECTION 004373 - PROPOSED SCHEDULE OF VALUES FORM

PART 1 - GENERAL

1.1 PROPOSED SCHEDULE OF VALUES FORM

A. Proposed Schedule of Values Form: Provide a breakdown of the bid amount, including alternates, in enough detail to facilitate continued evaluation of bid. Coordinate with the Project Manual table of contents. Provide multiple line items for principal material and subcontract amounts in excess of five percent of the Contract Sum.

B. Arrange schedule of values using AIA Document G703-1992.

1. Copies of AIA standard forms may be obtained from the American Institute of Architects; https://www.aiacontracts.org/ library; (800) 942-7732.

END OF DOCUMENT - 004373

SECTION 010100 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

Work Description

A. Contractor use of site and premises.

B. Permits and Licenses.

C. Owner occupancy.

D. Project Funding.

1.2 RELATED SECTION

A. Section 010300 - Options - Description

1.3 WORK DESCRIPTION

Work Location: Federal Aviation Administration, Mike Monroney Aeronautical Center, FAA Headquarters Building (Building 1), Oklahoma City, Oklahoma, 73169.

A. Completion of Work: The Contractor shall be required to (a) commence Work under this contractor within the designated calendar days after the date the Contractor receives the notice to proceed, (b) execute the Work diligently, and (c) complete the entire Work ready for occupancy and use not later than: Fall 2027

B. Work includes mechanical and electrical upgrades to HQB-001. The work shall be phased to accommodate continued operations wthin the facility.

C. Work DOES NOT Include:

1. Furnishing or installation of new or existing furniture, except as specifically noted.
2. Furnishing or installation of new communications or security equipment and cabling.

1.4 CONTRACTOR USE OF THE SITE AND PREMISES

A. Limit use of site and premises to allow:

1. Owner occupancy.

2. Work by others.

a. FAA IT personnel will be installing telecommunications.
b. Johnson Controls will be working concurrently with the Contractor on the installation of the New Controls system.

3. Access to Site: Coordinate site access and staging areas with FAA project manager prior to commencement of work.

B. Security Requirements: Contractor shall comply with all applicable Department of Transportation (DOT), FAA, and MMAC security directives while performing Work of this contract.

C. User / Owner Occupancy: The building will remain partially occupied during the duration of this project. The Contractor shall make every effort to not disrupt the day to day operations of this facility. The Contractor will be responsible for providing safety barriers, warnings, temporary lighting, heating and other appurtenances necessary to keep the occupants safe. Contractor shall provide temporary dust-proof partitions to demark exit travel and maintain safe egress from the building for the second floor occupants of the building at all times. At least three means of egress from each floor are required to be accessible at all times.

D. Time Restrictions – Base Bid: Work shall be conducted between 6:00 a.m. and 6:00 p.m. on normal government workdays. No Work, with the exception of the demolition work as described below, shall occur at night, or on Saturday's, Sunday's or designated government holidays unless approved by the Contracting Officer seven (7) days in advance.

1. All demolition including the removal of the existing concrete slab, sub-soil removal below existing concrete slab, demolition and removal of interior GWB and CMU partitions, windows, floor, wall and ceiling finishes, HVAC equipment and ductwork, plumbing and waste lines and vents, electrical demolition and removal, and any or all other items related to demolition, shall be between the hours of 6:00 P.M and 6:00 A.M Monday thru Friday. Work on the demolition may also be accomplished on weekends and approved government holidays. Work during these times (weekend and government holidays), must be pre-approved and scheduled in advance. Provide a minimum of seven (7) days prior notice to AMP-400, Project Manager, Mike Monroney Aeronautical Center, 405-954-4574 to coordinate scheduling of any work to be done outside of the occupants normal working hours.

E. Utility Outages and Shutdown: Coordinate with Contracting Officer Representative. Outages affecting FAA Operations are required to be accomplished during Saturdays, Sundays or designated government holidays. Prior to any outage or shutdown, seven (7) working days notification must be made to coordinate scheduling of any Work to be performed during any hours.

F. The Contractor will be responsible for providing safety barriers, warnings, temporary lighting, heating, air conditioning, ventilation and other appurtenances necessary to keep the occupants safe. Contractor shall provide temporary dust-proof partitions to demark exit travel and maintain safe egress from building for the occupants of the building at all times.

1.5 PERMIT AND LICENSES

A. Contractor shall secure and pay for all permits, licenses, etc. required in the execution of the Work, whether of a permanent or temporary nature.

1.6 SCHEDULE OF VALUES

A. The successful bidder will be required to, within 20 days after the date established as the Notice to Proceed, submit to the FAA a detailed schedule of values that clearly sets forth the scheduled prices for each component of the project. The Contractor will also be asked to provide a detailed cost breakdown.

B. All schedule of Values will include a line item for Project Closeout. This line item would be valued at (5% to 10%).

C. Concrete slab demolition and removal.

1. Construction of new concrete slab at the first floor base bid and Option 1 area, including reinforcing and perimeter insulation.

2. Sub-soil removal and disposal and replacement and compaction of new sub-soil for the base bid and Option 1 area.

3. Removal and replacement of the existing windows at the first floor base bid area.

4. Mechanical Systems

5. Fire Protection Systems

6. Electrical Systems.

7. Other items as requested by the Contracting Officer.

D. This Project will be required to comply with the "Buy American Act."

END OF SECTION - 010100

SECTION 010190 - CONTRACT CONSIDERATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Schedule of values.

1.2 RELATED SECTIONS

A. Section 010100 – Summary of Work: Schedule of additional cost items to be included in the Schedule of Values.

B. Section 010300 – Options: Description of options that may or may not be considered.

C. Section 016000 - Material and Equipment: Product substitutions and options.

1.3 SCHEDULE OF VALUES

A. Submit a printed schedule on Contractor's standard form or electronic media printout.

B. Submit Schedule of Values and Detailed Schedule of Values in duplicate within twenty (20) days after date established in Notice to Proceed.

C. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the major Specification Section. Identify site mobilization, bonds and insurance.

D. Include separately for each line item, a direct proportional amount of Contractor's overhead and profit.

E. Revise schedule to list approved Change Orders, with each Application for Payment.

F. Include any additional items for breakdown as requested by the FAA project manager.

G. This Project is required to comply with the "Buy America Act."

1.4 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER

A. This provision specifies the procedure for determination of time extensions for unusually severe weather in accordance with the contract clause entitled "Default: (Fixed Price Construction)". In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

1. The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.

2. The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the contractor

B. The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

1. MONTHLY ANTICIPATED ADVERSE WEATHER DELAY WORK DAYS BASED ON A FIVE (5) DAY WORK WEEK.

a. January - three (3) work days
b. February - three (3) work days
c. March - four (4) work days
d. April - four (4) work days
e. May - five (5) work days
f. June - four (4) work days
g. July - three (3) work days
h. August - three (3) work days
i. September - four (4) work days
j. October - three (3) work days
k. November - two (2) work days
l. December - two (2) work days.

END OF SECTION

SECTION 0010280 - MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittals.

B. Documentation of change in Contract Sum and Contract Time.

C. Change procedures.

D. Construction Change Directive.

E. Stipulated Sum change order.

F. Unit price change order.

G. Time and material change order.

H. Execution of change orders.

I. Correlation of Contractor submittals.

J. Weather Related Delays

1.2 RELATED SECTIONS

A. Section 012900 - Payment Procedures: Payment applications

B. Section 013000 - Submittals: Work schedule and schedule of values.

C. Section 016000 - Material and Equipment: Product options and substitutions.

D. Section 017000 - Contract Closeout: Project record documents.

1.3 SUBMITTALS

A. Submit name of the individual authorized to receive change documents, and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.

B. Change Order Forms: Format provided in Document 000800.

1.4 DOCUMENTATION OF CHANGE IN CONTRACT SUM AND CONTRACT TIME

A. Maintain detailed records of work done on a time and material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs of changes in the Work.

B. Document each quotation for a change in cost or time with sufficient data to allow evaluation of the quotation.

C. On request, provide additional data to support computations:

1. Quantities of products, labor, and equipment.
2. Taxes, insurance, and bonds.
3. Overhead and profit.
4. Justification for any change in Contract Time.
5. Credit for deletions from Contract, similarly documented.

D. Support each claim for additional costs, and for work done on a time and material basis, with additional information:

1. Origin and date of claim.
2. Dates and times work was performed, and by whom.
3. Time records and wage rates paid.
4. Invoices and receipts for products, equipment, and subcontracts, similarly documented.

1.5 CHANGE PROCEDURES

A. The Architect/Engineer will advise of minor changes in the Work not involving an adjustment to Contract Sum or Contract Time as authorized by AIA A201, 1987 Edition, Paragraph 7.4 by issuing supplemental instructions on AIA Form G710.

B. The Architect/Engineer may issue a Proposal Request which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor will prepare and submit an estimate within 10 days.

C. The Contractor may propose a change by submitting a request for change to the Architect/Engineer, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors. Document any requested substitutions in accordance with Section 016000.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Architect/Engineer may issue a document, signed by the Owner, instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

B. The document will describe changes in the Work, and will designate method of determining any change in Contract Sum/Price or Contract Time.

C. Promptly execute the change in Work.

1.7 STIPULATED SUM CHANGE ORDER

A. Based on Proposal Request and Contractor's fixed price quotation or Contractor's request for a Change Order as approved by Architect/Engineer.

1.8 UNIT PRICE CHANGE ORDER

A. For pre-determined unit prices and quantities, the Change Order will be executed on a fixed unit price basis.

B. For unit costs or quantities of units of work which are not pre-determined, execute Work under a Construction Change Directive.

C. Changes in Contract Sum or Contract Time will be computed as specified for Time and Material Change Order.

1.9 TIME AND MATERIAL CHANGE ORDER

A. Submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.

B. Architect/Engineer will determine the change allowable in Contract Sum/Price and Contract Time as provided in the Contract Documents.

C. Maintain detailed records of work done on Time and Material basis.

D. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.

1.10 EXECUTION OF CHANGE ORDERS

A. Execution of Change Orders: Architect/Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

1.11 CORRELATION OF CONTRACTOR SUBMITTALS

A. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

B. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.

C. Promptly enter changes in Project Record Documents.

1.12 Weather Related Delay Claims

A. Extension of Time of Completion. The Contractor may be entitled to an extension in time only when: a) The claim for such extension is submitted to the Program Manager and City Engineer in writing by the Contractor within seven (7) days from and after the time when the alleged cause of delay occurred which was beyond the Contractor¢s control; and b) Then only when such claim is approved by the Program Manager and City Engineer. In adjusting the time for completion of the project, all strikes, lockouts, unusual delays in transportation or any condition over which the Contractor has no control unless and except delays by a subcontractor deemed to be within the control of the Contractor and any suspensions of activities ordered by the Program Manager and City Engineer for causes not the fault of the Contractor shall be excluded from the computation of the Contract time for the completion of the work.

B. If the satisfactory execution and completion of the Contract should require work or materials in greater amount or quantities than those set forth in the contract, then the Contract time may be increased by the Program Manager and City Engineer. No allowance shall be made for delays or suspensions of the prosecution of the work due to the fault of the Contractor.

C. If the Contractor wishes to make a claim for an increase in the Contract time, written notice as provided herein shall be given. The Contractor¢s claim shall include an estimate of cost and of probable effect of delay on progress of the work. In the case of a continuing delay, only one claim is necessary.

D. If adverse weather conditions are the basis for a claim for additional time, such claim shall be documented by data substantiating that weather conditions were abnormal for the period of time and could not have been reasonably anticipated, and that weather conditions had an adverse effect on the construction activities occurring on the critical path of the construction schedule.

Based on Oklahoma City climatological data, the number of lost days a contractor should expect during an average year for exterior weather sensitive activities has been determined. The figures are based on the number of days each month that receive precipitation greater than ½ inch and/or snowfall over one inch. No days have been included for drying time.

Days	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lost	3	3	4	4	5	4	3	3	4	3	2	2

The lost weather days should be included in the schedule for the normal five-day work week (excluding weekends and holidays) for the duration of the project. Weather days exceeding lost days may be submitted for approval to the Architect/Engineer, Program Manager and City Engineer, which may extend the completion time for the project.

END OF SECTION

SECTION 010300 - OPTIONS

PART 1 - BASE BID

1.1 GENERAL

A. Protect existing flooring and FF&E.

1.2 ARCHITECTURAL

A. Build out new electrical closets including HVAC, lighting, electrical and fire protection requirements.

B. Provide new ceiling grid and tile in areas of base bid.

C. Where furniture and/or equipment must be moved in order to accomplish work, give minimum of 7 day notice to AMP-400 project manager, who will coordinate with FAA moving services to accomplish the move.

D. Build out new screen wall for new emergency power generator.

1.3 MECHANICAL

A. Replace AHU-1 in basement and associated local ductwork as well as basement fan coil units as noted on plans.

B. Provide new medium pressure natural gas supply feed and associated meter in basement for replacement generator.

C. Replace HVAC terminal units as noted on plans.

D. Replace existing control valves and sensors with DDC as noted on plans.

E. Add new isolation dampers to main duct branches at the shafts for each floor to be isolated.

F. Install new mini split units as noted on plans.

1.4 ELECTRICAL

A. All electrical work and panel upgrades associated with HVAC upgrade.

B. Replace and upgrade panels identified as having insufficient spare capacity to support future growth.

C. Replace with same version equipment or newer equipment all overcurrent protection devices in panels with fused disconnects and antiquated breakers.

D. Upgrade the main service entrance surge protective device (SPD.) See sheet EP601 for further information.

E. Contractor shall replace fuses in existing bus plugs, any new fuses shall be utilized in the SCCA and AFHA studies. See sheets EP604 & EP605 for further information.

F. Remedy the existing electrical system code compliance issues. The majority of the code issues are remedied by providing new electrical closets that provide proper code required dedicated and working space. Overcurrent protection was also provided on the secondary side of some transformers where missing but required by code.

G. Replace building generator.

H. Replace generators automatic transfer switch with new life-safety and stand-by automatic transfer switches.

I. Separate the generator power system into separate life-safety and standby distribution systems.

J. Upgrade lighting and controls in each stairwell to provide normal and emergency egress lighting from top to bottom throughout each vertical stairwell per lighting plans. Also, provide temporary power for each stairwell as required throughout all phases of construction. See phasing plans.

K. Provide and install new lighting inverters on each floor in new electrical closets.

L. Provide HVAC power, Inverter power, receptacles and lighting controls in new electrical closets.

M. Contractor shall perform overcurrent protection coordination study and arc-flash analysis.

N. Identify / replace basement below-slab conduit and conductors with above slab routing.

1.5 **Bid Option 1**

A. Replace existing HVAC ductwork and associated transfers and appurtenances (on roof and in building) and controls as noted on plans.

B. Clean existing HVAC ductwork (on roof and in building) and controls as noted on plans.

1.6 **Bid Option 2**

A. Replace with same version equipment or newer equipment, all lighting and controls not included in base bid. See all lighting plan sheets for further information.

1.7 **Bid Option 3**

A. Replace existing in-slab walker raceway conductors and wiring devices as shown and noted on electrical power plans.

1.8 **Bid Option 4**

A. Replace carpet, wall base, and paint walls in areas as shown on IN105 through IN108 in the drawings. In particular, new finishes are not included in main corridors, which were updated to FAA standards in a previous project. Contractor is required to carefully raise systems furniture, files and other heavy office equipment in order to install new finishes.

1.9 **Bid Option 5**

A. Replace with same version equipment or newer equipment of fire alarm system. See plans for additional information.

1.10 **Bid Option 6**

A. Install new ERRCS system. See plans for additional information.

END OF SECTION - 010300

SECTION 0010390 - COORDINATION AND MEETINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Coordination.

B. Pre-construction meeting.

C. Progress meetings.

D. Examination.

E. Preparation.

F. Cutting and Patching.

G. Alteration Project procedures.

1.2 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various Sections of the Project Manual to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Coordinate completion and clean up of Work of separate Sections in preparation for Substantial Completion.

1.3 PRE-CONSTRUCTION MEETING

A. Contracting Officer will schedule a meeting after Notice of Award.

B. Attendance Required: Contracting Officer, Project Manager, and Contractor.

C. Agenda:

1. Distribution of Contract Documents.

2. Submission of list of Subcontractors, list of Products, schedule of values, and progress schedule.

3. Designation of personnel representing the parties in Contract.

4. Procedures and processing of field decisions, Submittals, Substitutions, Applications for Payments, Proposal Request, Change Orders, and Contract Closeout procedures.

5. Project Safety Plan Submittal by the Contractor to the FAA. Written Programs and Plans for:

    a. Hazardous Work included in this Project.
    b. Fall Protection Methods
    c. Hazardous Material Procedures
    d. Emergency Action Plan
    e. Other topics at the Contractors discretion.

6. Scheduling.

D. Record minutes and distribute electronic copies within seven (7) days after meeting to Contracting Officer, Project Manager and all participants, and those affected by decisions made.

1.4 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work. These meetings will occur at a maximum of weekly and a minimum bi-weekly, unless otherwise required by the Contracting Officer.

B. Make arrangements for meetings, prepare agenda with copies for participants; preside at meetings.

C. Attendance Required: Job Superintendent, major Subcontractors and suppliers, Contracting Officer, Project Manager and others as appropriate to agenda topics for each meeting.

D. Agenda:

1. Review minutes of previous meetings.

2. Review of Work in progress.

3. 3 Week Look Ahead

    a. Field observations
    b. Identification of problems which impede planned progress

4. Status of Submittals, RFIs and RFPs

5. Maintenance of progress schedule.

    a. Review of off-site fabrication and delivery schedules
    b. Corrective measures to regain projected schedules
    c. Effect of proposed changes on progress schedule and coordination

6. Testing planned and required in accordance with contract requirements

7. Quarterly Environmental and Safety discussion to review MMAC policies and operational controls.

E. Record minutes and distribute electronic copies within seven (7) days after meeting to Contracting Officer, Project Manager and participants, and those affected by decisions made.

END OF SECTION - 010390

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SECTION 0010450 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

A. Definition: “Cutting and Patching” includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting and patching required to restore surfaces to their original condition.

1. Cutting and patching is performed for coordination of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed for other similar purposes.

a. Areas where Cutting and Patching occurs should be inspected to determine if ACM exists. If material is determined to be ACM, inform the Owner and Architect and develop a plan to mitigate any disturbance of the ACM.

2. Cutting and patching performed during the manufacture of products, or during the initial fabrication, erection or installation processes is not considered to be “cutting and patching” under this definition. Drilling of holes to install fasteners and similar operations are also not considered to be “cutting and patching”.

3. “Demolition” and “Selective Demolition” are recognized as related-but-separate categories of work, which may or may not require cutting and patching as defined in this section; refer to “Minor Demolition for Remodeling” sections of Division 2.

B. Refer to other sections of these specifications for specific cutting and patching requirements and limitations applicable to individual units of work.

1. Unless otherwise specified, requirements of this section apply to mechanical and electrical work. Refer to Division 15 and Division 16 sections for additional requirements and limitations on cutting and patching of mechanical and electrical work.

1.2 QUALITY ASSURANCE

A. Requirements for Structural Work: Refer to Section 024119 "Selective Demolition". Do not cut and patch structural work in a manner that would result in a reduction of load-carrying capacity or of load-deflection ratio. Prior to such work, obtain approval of projects structural engineer.

B. Before cutting and patching the following categories of work, obtain the Contracting Officer’s approval to proceed.

1. Structural steel.

2. Miscellaneous structural metals, including lintels, equipment supports, and similar categories of work.

3. Structural concrete.

4. Foundation construction.

5. Retaining walls.

6. Structural decking.

7. Roofing system.

8. Piping, ductwork, vessels and equipment.

9. Shoring, bracing, and sheeting.

10. Primary operational systems and equipment.

11. Noise and vibration control elements and systems.

12. Control, communication, conveying, and electrical wiring systems.

C. Visual Requirements: Do not cut and patch work exposed on the building's exterior or in it's occupied spaces in a manner that would, in the Contracting Officer's opinion, result in lessening the building's aesthetic qualities. Refer to the demolition drawings provided as part of the construction documents. Ask questions prior to performing cutting and patching work rather than after such performance. Do not cut and patch work in a manner that would result in substantial visual evidence of cut and patch work. Remove and replace work judged by the Contracting Officer to be cut and patched in a visually unsatisfactory manner.

1.3 SUBMITTALS

A. Procedural Proposal for Cutting and Patching: Where prior approval of cutting and patching is requested, submit proposed procedures for this work well in advance of the time work will be performed and request approval to proceed. Include the following information, as applicable, in the submittal:

1. Describe nature of the work and how it is to be performed, indicating why cutting and patching cannot be avoided. Describe anticipated results of the work in terms of changes to existing work, including structural, operational and visual changes as well as other significant elements.

2. List products to be used and firms including their qualifications that will perform the work.

3. Give dates when work is expected to be performed.

4. List utilities that will be disturbed or otherwise affected by work, including those that will be relocated and those that will be out of service temporarily. Indicate how long utility service will be disrupted.

5. When cutting and patching of structural work involves the addition of reinforcement, submit details and engineering calculations to show how that reinforcement is integrated with original structure to satisfy requirements.

6. Do not cut through the existing roofing system without proper approval from the Contracting Officer. Any work on the existing roof must be done in such a manner and with proper authorization as not to void the roof warranty.

7. Waste Management Plan in accordance with AMS Clause # 3.6.3-22

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Except as otherwise indicated, or as directed by the Contracting Officer, use materials for cutting and patching that are identical to existing materials. If identical materials are not available, or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

1. The use of a trade name and suppliers name and address is to indicate a possible source of the product. Products of the same type from other sources shall not be excluded provided they possess like physical and functional characteristics.

2. Patch with similar or comparable systems and with approval from the warranty holders so that existing warranties are not voided.

3. Patch existing roof system with like or similar system and with the approval of the original manufacturer so that the existing roof system warranty is maintained.

PART 3 - EXECUTION

3.1 INSPECTION

A. Before cutting, examine the surfaces to be cut and patched and the conditions under which the work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding with the work.

1. Before the start of cutting work, meet at the work site with all parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict between the various trades. Coordinate layout of the work and resolve potential conflicts before proceeding with the work.

3.2 PREPARATION

A. Temporary Support: To prevent failure provide temporary support of work to be cut.

B. Protection: Protect other work during cutting and patching to prevent damage. Provide protection from adverse weather conditions of that part of the project that may be exposed during the cutting and patching operations.

1. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

C. Take precaution not to cut existing pipe, conduit or duct serving the building but scheduled to be relocated until provisions have been made to bypass them.

D. When machinery can damage municipal roads or parking lots to access the work site, protect the roads and lots.

3.3 PERFORMANCE

A. General: Employ skilled workmen to perform cutting and patching work. Except as otherwise indicated or as approved by the Contracting Officer, proceed with cutting and patching at the earliest feasible time and complete work without delay.

B. Cutting: Cut the work using methods that are least likely to damage work to be retained or adjoining work. Where possible review proposed procedures with the original installer; comply with original installers recommendations.

1. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut through concrete and masonry using a cutting machine such as a carborundum saw or core drill to insure a neat hole.

2. Cut holes and slots neatly to size required with minimum disturbance of adjacent work. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces. Temporarily cover openings when not in use.

3. Comply with requirements of other applicable sections where cutting and patching requires excavating and backfilling.

4. By-pass utility services such as pipe and conduit, before cutting, where such utility services are shown or required to be removed, relocated or abandoned. Cut-off conduit and pipe in walls or partitions to be removed. After by-pass and cutting, cap, valve or plug and seal tight remaining portion of pipe and conduit to prevent entrance of moisture or other foreign matter.

C. Patching: Patch with seams which are durable and as invisible as possible. Comply with specified tolerances for the work..

1. Where feasible, inspect and test patched ares to demonstrate integrity of work.

2. Restore exposed finishes of patched areas and where necessary extend finish restoration into retained adjoining work in a manner which will eliminate evidence of patching and refinishing

3. Where removal of walls or partitions extends one finished area into another finished area, patch and repair floor and wall surfaces in the new space to provide asn even surface of uniform color and appearance. If necessary to achieve uniform color and appearance, remove existing floor and wall coverings and replace with new materials.

    a. Where patch occurs in a smooth painted surface, extend final paint coat over entire unbroken surface containing patch, after patched area has received prime and base coat.

4. Patch, repair or rehang existing ceiling as necessary to provide an even plane surface of uniform appearance.

5. Patch existing roof system with like or similar system to maintain positive drainage to roof drains and watertight roof membrane.

3.4 CLEANING

A. Thoroughly clean areas and spaces where work is performed or used as access to work. Remove completely paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit, and similar features before painting or other finish is applied. Restore damage pipe covering to it’s original condition.

END OF SECTION - 010450

SECTION 012100 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.

B. Types of allowances include the following:

1. Quantity allowances.

C. Related Requirements:

1. Section 010280 "Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

A. Allowance: A quantity of work or dollar amount included in the Contract, established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

1.4 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.

B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

C. Purchase products and systems selected by Architect from the designated supplier.

1.5 ACTION SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.6 INFORMATIONAL SUBMITTALS

A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.7 QUANTITY ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include **taxes,** freight and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

1.8 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, required maintenance materials, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.

3. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased or decreased costs due to a change in the scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES (Edit below per project requirements)

A. Allowance No. 1: Lump-Sum Allowance: Include the sum of $5,000.00 for the repairs required to patch opening in fire rated walls and floor assemblies. This allowance is for missing fire stopping or opening in walls that currently exist and does not cover the firestopping of new penetrations or new fire walls required or shown as part of the new work. The contractor shall inventory walls and floors for missing firestopping materials and wall assemblies prior to work in that area and notify the contracting manager. Provide a summary of cost to the contracting manager prior to work in those areas.

1. This allowance includes material, receiving, handling, and installation costs, and Contractor overhead and profit.

END OF SECTION

SECTION 013000 - SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittal Schedule.

B. Submittal procedures.

C. Format Of Submittals.

D. Construction progress schedules.

E. Proposed Products list.

F. Waste Management Plan in accordance with AMS Clause # 3.6.3-22

1.2 RELATED SECTIONS

A. Section 014000 - Quality Requirements: Manufacturers' field services and reports.

B. Section 017000 - Contract Closeout: Contract warranties, bonds, manufacturers' certificates, and closeout submittals.

1.3 SUBMITTAL SCHEDULES

A. Submit to the Contracting Officer an electronic submittal schedule at the first progress meeting. Schedule shall include but not be limited to specification Section number, specification title, paragraph number, and/or drawing number, description of submitted item, date submitted, date to location, reviewer action. Update the schedule at each subsequent progress meeting. Refer to example of schedule as attached at the end of this Section.

1.4 SUBMITTAL PROCEDURES

A. Transmit each submittal with Contracting Officer accepted completed transmittal form as attached to this specification Section.

B. Sequentially number the transmittal forms. Revise submittals with original number and a sequential alphabetic suffix. Example: 262200-01-00 - Low Voltage Transformers. If a resubmittal is required, the subsequent submittal number would be 262200-02-01 - Low Voltage Transformers.

C. Identify Project, Contractor, Subcontractor or Supplier; pertinent drawing and detail number, and specification Section number, as appropriate.

D. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents. If the Contractor's review has not been completed, the submittal will be returned with no action.

E. Schedule submittals to expedite the Project. Electronically deliver submittals to Architect at ca@fsb-ae.com. The Architect will review the submittal and forward to the Contracting Officer's e-mail address for review. Coordinate submission of related items.

F. For each submittal for review, allow fourteen (14 Calendar days) excluding delivery time to and from the Contractor.

G. Identify variations from Contract Documents and Product or system limitations, which may be detrimental to successful performance of the completed Work.

H. Provide space for Architect, Contractor and Contracting Officer review stamps.

I. On submittals that are catagorized as "revise and resubmit", identify all changes made since previous submission.

J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with provisions.

K. Submittals not requested will not be recognized or processed.

L. Waste Management Plan in accordance with AMS Clause # 3.6.3-22. Periodic (monthly) demolition waste management/disposition inventories should be submitted.

1.5 FORMAT OF SUBMITTALS

A. Electronic submittals are preferred. Coordinate procedure with the project manager. Submittals of entire systems shall be submitted as a complete unit with necessary appurtenances related and/or a part of the systems unit. Systems shall be defined as follows but not limited to those listed: HVAC, plumbing, and any other system which will require sub-systems for the system to work in a manner as designed in the Contract Documents.

B. Identifying Submittals: Identify submittals, except sample panel and sample installation, with the following information permanently adhered to or noted on each separate component of each submittal and noted on the transmittal form. Tab indexed Section dividers as required to separate components or Products. Mark each copy of each submittal identically, with the following:

1. Project title and location.

2. Construction contract number.

3. The Section number of the specification Section by which the submittal is required (262200-01-00 - Low Voltage Transformers).

4. The name, address, and telephone number of the Subcontractor, supplier, manufacturer and any other second tier Contractor associated with the submittal.

5. Product identification and location in Project.

C. Format for Product Data:

1. Submit electronic copies which the Contract requires, one (1) copy the Contractor shall submit as a Project record documents in accordance with Section 017000. Present Product data submittals for each Section as a complete submittal. Include a table of contents listing page and catalog item numbers for Product data.

2. Indicate, by prominent notation, each Product which is being submitted; indicate the specification Section number and paragraph number to which it pertains. Identify applicable Products, models, options, and other data. Provide results of test reports specified in each specification Section. Supplement manufacturers' standard data to provide information unique to this Project.

3. Indicate Product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

4. Supplement Product data with material prepared for the Project to satisfy submittal requirements for which Product data does not exist. Identify this material as developed specifically for the Project.

5. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 017000 - "Contract Closeout".

D. Format for Shop Drawings:

1. Electronic submittals are preferred. Coordinate procedure with the project manager.

2. Shop drawings shall not be less than 8 1/2 by 11 inches nor more than 30 x 42 inches. Present 8-1/2 x 11-sized shop drawings as a part of the bound volume for the submittals required by the Section. Present larger drawings in sets. Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to the information required in the paragraph entitled "Identifying Submittals." Dimension drawings, except diagrams and schematic drawings; prepare drawings demonstrating interface with other trades to scale. Identify materials and Products for Work shown.

3. Shop Drawings: Submit for review. After review, produce copies and distribute in accordance with the SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 017000 - "Contract Closeout".

4. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. Format of Samples:

1. Furnish samples in the sizes below, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately the same size as specified:

   a. Sample of Equipment or Device: Full size.
   b. Sample of Materials less than 2 by 3 inches: Built up to 8 1/2 by 11 inches.

c. Sample of Materials exceeding 8 1/2 by 11 inches: Cut down to 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations.
d. Sample of Linear Devices or Materials: 10-inch length or length to be supplied, if less than 10 inches. Examples of linear devices or materials are conduit and handrails.
e. Sample of Non-Solid Materials: Pint. Examples of non-solid materials are sand and paint.
f. Color Selection Samples: 2 inches by 4 inches.
g. Sample Panel: 4 feet by 4 feet.
h. Sample Installation: 100 square feet.

2. Submit the number of samples specified in individual specification Sections; one of which will be retained by Contracting Officer.

3. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing Work.

4. Submit samples of finishes from the full range of manufacturers' standard colors, textures, and patterns for Contracting Officer selection, if color is not specified or indicated on the Drawings.

5. Samples Showing Range of Variation: Where variations are unavoidable due to the nature of the materials, submit sets of samples of not less than three units showing the extremes and middle of the range.

6. Reusable Samples: Incorporate returned samples into the Work only if so specified or indicated. Incorporated samples shall be in undamaged condition at the time of use.

7. Recording of Sample Installation: Note and preserve the notation of the area constituting the sample installation but remove the notation at the final clean up of the Project.

8. When a color, texture or pattern is specified in naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

F. Format of Administrative Submittals:

1. When the submittal includes a document which is to be used in the Project or become a part of the Project record, other than as a submittal, do not apply the Contractor's approval stamp to the document, but to a separate sheet accompanying the document.

2. Operation and Maintenance Manual Data: Submit in accordance with Section 017300, "Operation and Maintenance Data". Include components required in that Section and the various technical Sections.

3. Waste Management Plan in accordance with AMS Clause # 3.6.3-22. Periodic (monthly) demolition waste management/disposition inventories should be submitted.

G. Manufacturer Installation Instructions:

1. When specified in individual specification Sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Contracting Officer in quantities specified for Product Data.

2. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

H. Manufacturer Certificates:

1. When specified in individual specification Sections, submit certification by manufacturer to Contracting Officer, in quantities specified for Product Data.

2. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

3. Certificates may be recent or previous test results on material or Product, but must be acceptable to Contracting Officer.

1.6 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial baseline schedule within five (5) days after date established in Notice to Proceed.

B. Construction progress schedule shall have construction activity line items that correspond to the schedule of values as listed in Section 010190- "Contract Considerations".

C. Revise and resubmit the construction progress schedule to reflect the actual progress of construction. The original baseline schedule shall not change except, as permitted with approved extension of time.

D. Submit revised schedules with each Application for Payment, identifying changes since previous version. The application for payment shall not be considered complete, and the application will not be processed until the schedule or revised schedule is submitted.

E. Submit a computer-generated chart with separate line for each major activity or Section of Work, identifying first workday of each week.

F. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

G. Indicate estimated percentage of completion for each item of Work at each submission.

H. Indicate submittal dates required for shop drawings, Product data, samples, and Product delivery dates, in relationship to the scheduled installation.

1.7 PROPOSED PRODUCTS LIST

A. Within fifteen (15) days after date of Notice to Proceed, submit list of major Products proposed for use, with name of manufacturer, trade name, and model number of each Product.

B. For Products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

END OF SECTION - 013000

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including F.A.A. General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.

2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.

3. Requirements for Contractor to provide quality-control services required by Owner Representative, Contracting Officer, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:

1. Divisions 2 through 16 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Owner Representative.

C. Mockups: Full-size, physical example assemblies to illustrate finishes and materials. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Mockups establish the standard by which the Work will be judged.

D. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.4 DELEGATED DESIGN

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Owner Representative.

1.5 REGULATORY REQUIREMENTS

A. Reference F.A.A. General and Supplementary Conditions.

1.6 SPECIAL INSPECTIONS

A. The Contractor shall be required to acquire the services of an independent testing and inspection firm(s) to oversee and certify all Special Inspections required by the City of Oklahoma City and IBC (current version adopted by The City of Oklahoma City). These independent firms shall not be affiliated with or have had any business relation, nor any other relationship that would imply any conflict of interest with respect to the Contractor. The fees for such testing and inspections shall be included in the Base Bid amount.

B. The Headquarter Building is on OCAT leased land and adjacent to runways, airway clearance is required by registering objects over 27’ high. The Contractor shall perform the survey for crane use and obtain approval from the Director of Airport Operations. A survey is required at the conclusion of the project to register a new building, light poles, and constructed object over 27’ high.

1.7 SUBMITTALS

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services. All work performed, including by not limited to Building, Mechanical, Electrical, and Plumbing of each portable and modular unit shall be performed by licensed craftsmen to perform work in Oklahoma County and the City of Oklahoma City. Each unit shall bear certificates of approval from the City Of Oklahoma City and authorities having jurisdiction in Oklahoma County, Oklahoma.

C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

D. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

E. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work 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.

D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located 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 product that are similar to those

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

G. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

H. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

I. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.

1. Contractor responsibilities include the following:

   a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
   b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.
   d. When testing is complete, remove assemblies; do not reuse materials on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Owner Representative, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Owner Representative.

2. Notify Owner Representative seven (7) days in advance of dates and times when mockups will be constructed.

3. Demonstrate the proposed range of aesthetic effects and workmanship.

4. Obtain Owner Representative approval of mockups before starting work, fabrication, or construction.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

6. Demolish and remove mockups when directed, unless otherwise indicated.

1.9 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, or Contracting Officer, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.

2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.

3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

a. Contractor shall not employ the same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least forty-eight (48) hours in advance of time when Work that requires testing or inspecting will be performed.

3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.

4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Special Tests and Inspections: Owner will engage a testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.

1. Testing agency will notify Owner Representative, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.

2. Testing agency will submit a certified written report of each test, inspection, and similar quality-control service to Owner Representative with copy to Contractor and to authorities having jurisdiction.

3. Testing agency will submit a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.

4. Testing agency will interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

5. Testing agency will retest and reinspect corrected work.

D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Owner Representative, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Owner Representative, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.

2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.

3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.

4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.

5. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.

2. Incidental labor and facilities necessary to facilitate tests and inspections.

3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.

4. Facilities for storage and field-curing of test samples.

5. Delivery of samples to testing agencies.

6. Preliminary design mix proposed for use for material mixes that require control by testing agency.

7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within thirty (30) days of date established for the Notice to Proceed.

1. Distribution: Distribute schedule to Contracting Officer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.

2. Comply.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION - 014000

SECTION 015000 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, heat, cooling, ventilation, telephone service, water, and sanitary facilities.

B. Temporary Controls: Barriers, enclosures and fencing, protection of the Work, and water control.

C. Construction Facilities: Progress cleaning.

1.2 RELATED SECTIONS

A. Section 015900 – Field Offices and Sheds.

B. Section 017000 - Contract Closeout: Final cleaning.

1.3 TEMPORARY ELECTRICITY

A. Connect to FAA's existing power service. Do not disrupt FAA’s need for continuous service. FAA will pay cost of energy used. Exercise measures to conserve energy.

1.4 TEMPORARY LIGHTING

A. Permanent building lighting may be utilized during construction. It will be the responsibility of the Contractor to turn the lights off at the end of each day. FAA will pay cost of energy used.

1.5 TEMPORARY HEAT

A. Utilize FAA's existing heat plant, extend and supplement with Contractor supplied temporary heat devices as needed to maintain specified conditions for construction operations.

B. FAA will pay cost of energy used from existing heat plant. Contractor is responsible for paying for and maintaining temporary heating devices used or required during construction. Exercise measures to conserve energy

1.6 TEMPORARY COOLING

A. Contractor to furnish temporary cooling to occupied spaces of the building during all phases of construction.

B. FAA will pay the cost of energy used from temporary cooling. Contractor is responsible for paying for and maintaining temporary cooling devices used or required during construction. Exercise measures to conserve energy.

1.7 TEMPORARY VENTILATION

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

B. Utilize existing ventilation equipment. Extend and supplement equipment with temporary fan units as required to maintain clean air for construction operations.

1.8 TEMPORARY TELEPHONE

A. Contractor will be required to provide cellular or mobile phone service. FAA telephone service will not be available.

1.9 TEMPORARY WATER SERVICE

A. Connect to existing water source for construction operations.

B. FAA will pay cost of water used. Exercise measures to conserve water

C. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.

1.10 TEMPORARY SANITARY FACILITIES

A. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use by construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

B. At the end of construction, remove all temporary sanitary facilities and return site where located to same or better condition as originally found.

1.11 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas to allow for FAA's use of site and to protect existing facilities and adjacent properties from damage from construction operations.

B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.

C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.12 INTERIOR ENCLOSURERS

A. Provide temporary partitions as indicated to separate work areas from FAA occupied areas, to prevent penetration of dust, fumes and noise into FAA occupied areas, and to prevent damage to existing materials and equipment.

B. Construction: Framing of 2 x wood and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces. Maximum flame spread rating of 25 in accordance with ASTM E84.

1.13 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification Sections.

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to prevent damage.

1.14 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Collect and remove waste materials, debris, and rubbish from site daily and dispose off-site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

The Contractor may use existing utilities without charge, if available; however, the Contractor, at his own expense and in a workmanlike manner satisfactory to the Contracting Officer, shall furnish, install, and maintain all necessary temporary connections and distribution lines, and shall remove same prior to final acceptance of the construction.

END OF SECTION

SECTION 016000 - MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Transportation and handling.

C. Storage and protection.

D. Product options.

E. Substitutions.

1.2 RELATED SECTIONS

A. Section 014000 - Quality Requirements: Product quality monitoring.

1.3 PRODUCTS

A. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

B. Provide interchangeable components of the same manufacture, for components being replaced.

C. No asbestos containing materials can be used or installed on this project.

1.4 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct, and Products are undamaged.

C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

A. Store and protect Products in accordance with manufacturers' instructions, with seals and labels intact and legible.

B. Store sensitive Products in weather tight, climate controlled enclosures.

C. For exterior storage of fabricated Products, place on sloped supports, above ground.

D. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.

E. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation or potential degradation of Product.

F. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

G. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement, or damage.

H. Arrange storage of Products to permit access for inspection. Periodically inspect to verify Products are undamaged and are maintained in acceptable condition.

1.6 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any Product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

1.7 SUBSTITUTIONS

A. Contracting Officer will consider requests for Substitutions only within ten (10) days after award of Contract.

B. Substitutions may be considered when a Product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that the Contractor:

1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.

2. Will provide the same warranty for the Substitution as for the specified Product.

3. Will coordinate installation and make changes to other Work, which may be required for the Work to be complete with no additional cost to FAA.

4. Waives claims for additional costs or time extension, which may subsequently become apparent.

5. Will reimburse Contracting Officer for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or Product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution Submittal Procedure:

1. Submit three (3) copies of request for Substitution for consideration on Substitution Request Form attached to this Section. Limit each Substitution Request Form to one (1) proposed Substitution.

2. Submit shop drawings, Product data, and certified test results attesting to the proposed Product equivalence.

3. The Contracting Officer will notify Contractor in writing of decision to accept or reject request.

G. If request for substitution is not accepted by the Contracting Officer, Contractor is responsible for supplying item as originally specified or an acceptable substitution without additional cost to the FAA.

END OF SECTION - 016000

SECTION 016010 - SUBSTITUTIONS REQUEST FORM

PART 1 - GENERAL

SUBSTITUTIONS REQUEST FORM

To: Project Manager
Specified Item:

_____ ____ _____ _____
Section Page Paragraph Description

The undersigned requests consideration of the following:

Proposed Substitution: _____

_____

The undersigned certifies that the following paragraphs, unless modified or clarified by attachments, are correct:

1.1 The proposed substitution does not affect dimensions shown on the Drawings.

1.2 The undersigned will reimburse FAA for review or redesign services associated with re-approval by authorities.

1.3 The undersigned will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to FAA.

1.4 The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.

1.5 Maintenance and service parts will be locally available for the proposed substitution.

1.6 Attached data includes support items listed in Section 016000, and applicable portions of the data are clearly identified.

1.7 Attached data also includes a description of any revisions to the Contract Documents which the proposed substitution will require for its proper installation.

The undersigned further certifies that the function, appearance and quality of the proposed substitution are equivalent or superior to the specified item.

Submitted by:

Signature _____

Firm _____

Address _____

_____

Date _____

Telephone _____

List of Attachments:

For Use by the

DESIGN CONSULTANT
____Accepted
____Not Accepted
____Accepted As Noted
____Received Too Late

END OF SECTION - 016010

SECTION 016500 - STARTING OF SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Starting systems.

B. Demonstration and instructions.

C. Testing, adjusting, and balancing.

1.2 RELATED SECTIONS

A. Section 014000 – Quality Requirements: Manufacturers field reports.

B. Section 017000 – Contract Closeout: System operation and maintenance data and extra materials.

1.3 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify A/E Representative and Owner, in writing prior to start-up of each item.

C. Verify that each piece of equipment or systems has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.

D. Verify wiring and support components for equipment are complete and tested.

E. Verify that tests, meter reading, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

F. Execute start-up under supervision of applicable Contractors' personnel.

G. When specified in individual Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report in accordance with Section 014000 "Quality Requirements" that equipment or system has been properly installed and is functioning correctly.

1.4 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of final inspection.

B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners personnel in detail to explain all aspects of operation and maintenance.

D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time at equipment designated location.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

F. The amount of time required for instruction on each item of equipment is that specified in individual sections.

1.5 TESTING, ADJUSTING, AND BALANCING

A. Owner may appoint, employ, and pay for services of an independent firm to perform testing, adjusting, and balancing.

B. Reports will be submitted by the independent firm to the Architect indication observations and results of tests and indication compliance or non-compliance with the requirements of the Contract Documents.

END OF SECTION

SECTION 017000 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Procedures for final acceptance of the Project.

B. Closeout procedures.

C. Final cleaning.

D. Adjusting.

E. Warranties.

1.2 RELATED SECTIONS

A. Section 017300 – Operations and Maintenance Data: Providing operations and maintenance manuals and record drawings.

1.3 PROCEDURES FOR FINAL ACCEPTANCE OF THE PROJECT

A. Pre-final inspection:

1. When the Contractor has completed all Work and is satisfied the Project is in compliance with the Contract Documents; he will notify the Contracting Officer, in writing, that the Project is complete and ready for inspection. The Contracting Officer will arrange for and conduct an inspection of the Project by the Contracting Officer, Project Manager, and the Contractor. The Contracting Officer will be provided a reasonable time to arrange for and conduct an inspection.

2. The Contracting Officer will document any deficiencies on a written punch list and will arrange a meeting with the Contractor to review the punch list and explain all deficient items. The Contractor will correct the deficiencies and notify the Contracting Officer in writing, when the Project is ready for inspection of the deficient items. The Contracting Officer will arrange and conduct a reinspection of the Project to review the corrected items.

3. The formal list of deficiencies found shall not be considered a final list of all deficient items. Any deficiencies found during inspection for substantial completion, beneficial occupancy or inspection for final acceptance will be corrected by the Contractor per the Contract Documents, prior to final acceptance.

B. Instruction/Demonstration Operations of Systems and Equipment:

1. When the Contracting Officer has determined that the Project is sufficiently complete to allow instruction/demonstration of equipment (if required) to FAA's staff. The Contracting Officer will request, in writing, that the Contractor provide "Instruction and Demonstration on Operation of Systems."

2. Upon formal notice from the Contracting Officer, the Contractor will then arrange for instruction of the FAA's staff in the operation of the constructed systems. This includes submission of all outstanding record documents, including operating and maintenance manuals, equipment cuts, guarantees, warranties, maintenance contracts, and any additional instructions necessary for the operation of the systems. The Contractor will acquaint the FAA's staff with acceptance tests, guarantees, warranties, and maintenance manuals. The Contractor will also obtain a Certificate of Occupancy or similar releases required to permit the FAA's occupancy of the Project (if required) for this Project.

3. Should the Instruction/Demonstration Training find deficiencies, the Contracting Officer will notify the Contractor in writing of deficient items.

C. Substantial completion:

1. Upon completion of deficient items and instruction to the FAA, the Contractor will arrange for an inspection of the Project with the Contracting Officer and the Project Manager. This inspection may result in a list of additional items to complete after occupancy, but before the final payment and/or may require additional correction before occupancy by the FAA.

2. If the inspection confirms that the Project is "substantially complete" and is "ready for occupancy", the Contracting Officer will issue a "Certificate of Substantial Completion". The Certificate will confirm that the Project can be occupied for its intended use. Attached to the Certificate will be any final punch list items to be completed. Prior to issuance of the Certificate, the Contractor shall submit a schedule for completion of remaining deficiencies, verified or amended by the Contracting Officer.

D. Final inspection:

1. Upon completion of the remaining deficiencies the Contractor will notify the Contracting Officer in writing, that the Project is complete and ready for a final inspection. The Contracting Officer shall arrange for and conduct a final inspection of the Project.

E. Final acceptance:

1. If final inspection indicates satisfactory completion of the Work, the Project Manager, and the Contracting Officer will issue a change order adjusting to the final quantities. Following acceptance of the final change order, receipt of required affidavits, releases or waivers of lien, and consent of the surety for final payment the Project Manager will issue a final "Certificate for Payment."

F. Additional inspection:

1. Should the Project require inspections beyond inspections noted above, from pre-final through final inspection, the Contracting Officer will reduce from the Contractor's final payment those monies necessary to provide for the cost of the additional inspections. The reduction shall not be considered as a part of any "Liquidated Damages" for failure to complete within the specified contract time. The reduction shall not be considered as a penalty to the Contractor; but shall be for the actual cost of monies required for the reimbursement of fees for the Contracting Officer and other specialist necessary for acceptance of the Project.

G. Excessive deficiencies found during inspections:

1. During any inspection of Project completion, if it is determined by the Contracting Officer, that the Contractor has not sufficiently completed the Work in compliance to the Contract Documents, the Contracting Officer may declare that the Project is not sufficiently complete to continue inspection of the Work. Within three (3) working days, of the declaration, the Contracting Officer will issue in writing, a list of deficiencies found. The deficiency listed shall be understood as only a partial list and that the partial list may or may not represent deficiencies in areas that were not inspected.

1.4 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Contracting Officer's review.

B. Provide submittals to Contracting Officer that are required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

D. Submit with the final Application for Payment a complete certified list of Subcontractors and material suppliers. Accompanying the list shall be a lien waiver signed by each Subcontractor and material supplier as documentation verifying that payment has have been made for services and materials required for completion of this Contract. Lien waiver forms are available at the office of the Contracting Officer.

E. Contractor must certify that no asbestos materials have been used on the project.

1.5 FINAL CLEANING

A. Execute final cleaning prior to final Project assessment.

B. Clean surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces.

C. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

D. Clean site, only areas that were used for staging and adjacent areas that may need cleaning due to wind blown construction debris; sweep-paved areas, rake clean landscaped surfaces.

E. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.6 ADJUSTING

A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.7 WARRANTIES

A. Provide duplicate notarized copies.

B. Execute and assemble transferable warranty documents from Subcontractors, suppliers, and manufacturers.

C. Provide Table of Contents and assemble in three hole D side ring binder with durable plastic cover.

D. Prepare binder cover with printed title "WARRANTIES", and title of Project.

E. Submit prior to final Application for Payment.

F. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten (10) days after acceptance, listing date of acceptance as start of warranty period.

END OF SECTION - 017000

SECTION 017300 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Format and content of manuals.

B. Instruction of Owner's personnel.

C. Schedule of submittals.

1.2 RELATED SECTIONS

A. Section 013000 - Submittals: Submittals procedures. Shop drawings, product data, and samples.

B. Section 014000 - Quality Requirements: Manufacturers' instructions. Test and balance reports.

C. Section 016000 - Material and Equipment: Systems demonstration.

D. Section 017000 - Contract Closeout: Contract closeout procedures, project record documents.

E. Individual Specifications Sections: Specific requirements for operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

1.4 FORMAT

A. Prepare data in the form of an instructional manual.

B. Binders: Commercial quality, 8-1/2 x 11 inch three D side ring binders with durable covers. When multiple binders are used, correlate data into related consistent groupings.

C. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

D. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.

E. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.

F. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

G. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, in three parts as follows:

1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.

2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

   a. Significant design criteria.
   b. List of equipment.
   c. Parts list for each component.
   d. Operating instructions.
   e. Maintenance instructions for equipment and systems.
   f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3: Project documents and certificates, including the following:

   a. Shop drawings and product data.
   b. Air and water balance reports.
   c. Certificates.
   d. Photocopies of warranties and bonds.

1.5 CONTENTS, EACH VOLUME

A. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Architect/Engineer, Subconsultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

B. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

C. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

D. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

E. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 014000 "Quality Requirements".

F. Warranties: Bind in copy of each.

G. Bonds: Bind in photocopy of each.

1.6 MANUAL FOR MATERIALS AND FINISHES

A. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured Products.

B. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional Requirements: As specified in individual Product specification sections.

E. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

1.7 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

B. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

C. Include color coded wiring diagrams as installed.

D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

E. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

F. Provide servicing and lubrication schedule, and list of lubricants required.

G. Include manufacturer's printed operation and maintenance instructions.

H. Include sequence of operation by controls manufacturer.

I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

J. Provide control diagrams by controls manufacturer as installed.

K. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.

L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

M. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

N. Include test and balancing reports as specified in Section 014000 "Quality Requirements".

O. Additional Requirements: As specified in individual Product specification sections.

P. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.8 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times.

B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.

C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

D. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.9 SUBMITTALS

A. Submit three copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect/Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit 3 copies of completed volumes 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect/Engineer comments. Revise content of all document sets as required prior to final submission.

D. Submit four sets of revised final volumes in final form within 10 days after final inspection.

1.10 SCHEDULE OF SUBMITTALS

A. Material and Finishes: The following is a general list of Sections requiring submittal of maintenance data. Refer to individual specification Sections for submittal requirements.

1. Section 095113 - Acoustical Panel Ceilings.

2. Section 096513 - Resilient Base and Accessories.

3. Section 096813 - Tile Carpeting.

4. Section 099123 - Interior Painting.

5. Refer individual Sections for additional submittal requirements.

B. Equipment and Systems: The following is a general list of Sections requiring submittal of operation and maintenance data. Refer to individual specification Sections for submittal requirements.

1. Section 087100 - Door Hardware.

2. Section 283111- Digital, Addressable Fire Alarm System.

3. Refer individual Sections for additional submittal requirements.

END OF SECTION - 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.
4. Recycling demolition and construction universal waste.

B. RELATED SECTIONS

1. Section 024119 - Selective Demolition.
2. Section 042000 - Unit Masonry

C. RELATED DOCUMENTS

1. Refer to the FAA Construction Waste Management Requirements for Contracts (AMS Clause 3.6.3-22 Dated January 2020).
2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specifications Sections, apply to this Section.

1.2 DEFINITIONS

A. Construction Waste: Waste generated by construction activities, such as scrap materials, damaged or spoiled materials, temporary and expendable construction materials, and other waste generated by the workforce during construction activities.

B. Demolition Waste: Waste generated from demolition activities, including minor incidental demolition waste materials generated as a result of Intentional dismantling of all or portions of a building, to include clearing of building contents that have been destroyed or damaged.

C. Universal Waste: As regulated in Title 40 of the Code of Federal Regulations (CFR) in Part 273, includes batteries, pesticides, mercury-containing equipment, lamps and aerosol cans.

D. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction. Regulated in the US under the Resource Conservation and Recovery Act (RCRA).

E. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

F. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

G. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work. The use of a product or materials again for the same purpose, in its original form or with little enhancement or change.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 50 percent by weight of total non-hazardous solid waste generated by the Work. Facilitate recycling and salvage of materials.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 15 days after contract award prior to the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Submit report by the 15 th day of each month. Include the following information:

1. FAA facility name and address, report the date and reporting period, contract number and project name.

2. Material category.

3. Generation point of waste.

4. Total quantity of waste in tons.

5. Quantity of waste salvaged, both estimated and actual in tons.

6. Quantity of waste recycled, both estimated and actual in tons.

7. Total quantity of waste recovered (salvaged plus recycled) in tons.

8. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. Qualification Data: For waste management coordinator.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements. Superintendent may serve as Waste Management Coordinator.

B. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

C. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 010390 "Coordination and Meetings." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.

2. Review requirements for documenting quantities of each type of waste and its disposition.

3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.

4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.

5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with Section 024119 "Selective Demolition."

2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.

3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.

4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.

5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there were no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:

1. Total quantity of waste.

2. Estimated cost of disposal (cost per unit). Include transportation and tipping fees and cost of collection containers and handling for each type of waste.

3. Total cost of disposal (with no waste management).

4. Revenue from salvaged materials.

5. Revenue from recycled materials.

6. Savings in transportation and tipping fees by donating materials.

7. Savings in transportation and tipping fees that are avoided.

8. Handling and transportation costs. Include cost of collection containers for each type of waste.

9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS

2.1 RECYCLING RECEIVERS AND PROCESSORS

A. Subject to compliance with requirements, available recycling receivers and processors include, but are not limited to, the following:

1. Local recycling receivers and processors of recyclable materials to be determined by Contracting Officer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 50 percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:

a. Concrete.
b. Concrete reinforcing steel.
c. Wood studs.
d. Wood joists.
e. Plywood and oriented strand board.
f. Wood paneling.
g. Wood trim.
h. Structural and miscellaneous steel.
i. Rough hardware.
j. Insulation.
k. Doors and frames.
l. Door hardware.
m. Windows.
n. Glazing.
o. Metal studs.
p. Gypsum board.
q. Acoustical tile and panels.
r. Carpet.
s. Carpet pad.
t. Demountable partitions.
u. Equipment.

v. Cabinets.
w. Plumbing fixtures.
x. Piping.
y. Supports and hangers.
z. Valves.
aa. Sprinklers.
bb. Mechanical equipment.
cc. Refrigerants.
dd. Electrical conduit.
ee. Copper wiring.
ff. Lighting fixtures.
gg. Lamps.
hh. Ballasts.
ii. Electrical devices.
jj. Switchgear and panelboards.
kk. Transformers.

2. Construction Waste:

a. Lumber.
b. Wood sheet materials.
c. Wood trim.
d. Metals.
e. Insulation.
f. Carpet and pad.
g. Gypsum board.
h. Piping.
i. Electrical conduit.
j. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Wood pallets.
8) Plastic pails.

k. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

1) Paper.
2) Aluminum cans.
3) Glass containers.

l. List of other materials that are required to be recycled. Provided by Contractor.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 015000 "Construction Facilities and Temporary Controls."

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

1. Distribute waste management plan to everyone concerned within three days of submittal return.

2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated and sold.

2. Comply with Section 015000 "Construction Facilities and Temporary Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Comply with requirements in Section 024119 "Selective Demolition" for salvaging demolition waste.

B. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

3. Store items in a secure area until installation.

4. Protect items from damage during transport and storage.

5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

C. Salvaged Items for: Permitted on Project site.

D. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

3. Store items in a secure area until delivery to Owner.

4. Transport items to Owner's storage area designated by Owner.

5. Protect items from damage during transport and storage.

E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

G. Plumbing Fixtures: Separate by type and size.

H. Lighting Fixtures: Separate lamps by type and protect from breakage.

I. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3. Stockpile materials away from construction area. Do not store within drip line of remaining trees or structures.

4. Store components off the ground and protect from the weather.

5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

A. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum 1-1/2-inch size.

B. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

C. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.

2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

D. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

E. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

F. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.

G. Carpet: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

H. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

I. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.

J. Conduit: Reduce conduit to straight lengths and store by material and size.

K. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.

2. Polystyrene Packaging: Separate and bag materials.

3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.

2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner’s property.

C. Burning: Do not burn waste materials.

END OF SECTION

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.

B. Allowances: Furnish demonstration and training instruction time under the demonstration and training allowance as specified in Section 012100 "Allowances."

C. Unit Price for Instruction Time: Length of instruction time will be measured by actual time spent performing demonstration and training in required location. No payment will be made for time spent assembling educational materials, setting up, or cleaning up.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.5 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Systems and equipment operation manuals.
    c. Systems and equipment maintenance manuals.
    d. Product maintenance manuals.
    e. Project Record Documents.
    f. Identification systems.
    g. Warranties and bonds.
    h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.

c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning.
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

1.6 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017300 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.7 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.

2. Owner will furnish an instructor to describe Owner's operational philosophy.

3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner, through Architect, with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 019113 - General Commissioning Requirements

PART 1 - GENERAL

1.1 SUMMARY

A. The Commissioning Authority shall direct and coordinate all commissioning activities and the commissioning activities of all Contractors on the project.

B. Commissioning is intended to achieve the following objectives:

1. Verify that the project design meets the Owners Project Requirements.

2. Verify that the work is installed in accordance with the Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup.

3. Verify and document that functional performance is in accordance with the Contract Documents.

4. Verify that operations and maintenance manuals submitted to the Owner are complete.

5. Verify Contractor training activities are in accordance with the Contract Documents and meet the Owner's operator requirements.

1.2 DEFINITIONS AND ABBREVIATIONS

A. Definitions set forth in the General Conditions are applicable to this Section. In addition, the following definitions shall apply to the terms used in this section.

1. "Acceptance Phase" - Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.

2. "Approval" - Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.

3. "Commissioning Authority (CA)" - An independent agent, not otherwise associated with the A/E team members or the Contractor, though he/she may be hired as a Subcontractor to them. The CA directs and coordinates the day-to-day commissioning activities. The CA does not take an oversight role like the CM. The CA is part of the Construction Manager (CM) team or shall report directly to the CM.

4. "Commissioning Plan" - An overall plan, developed before or after bidding, that provides the structure, schedule and coordination planning for the commissioning process.

5. "Deferred Functional Tests" - FPT's that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.

6. "Deficiency" - A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents. Deficiencies shall be indicated on commissioning issue logs, observation reports or commissioning test results. Deficiencies are to be corrected by the installing Contractor until correct function is achieved.

7. "Field Installation Verification (FIV)" - Verification of all installed systems for compliance to plans and specification are listed under Prefunctional Tests. These inspections are to be described in detail in the commissioning plan. Primarily static inspections and procedures to prepare the equipment or system for initial operation

8. "Functional Performance Test (FPT)" - Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing Contractor or vendor. FPT's are performed after Field Installation Verification (FIV) and Operational Performance Tests (OPT) are complete

9. "Issue Log" - A report of issues discovered by the CA. Issue log entrees must be answered or responded to by the appropriate party having authority for the issue resolution.

10. "Observation Report" - A report of a field inspection by the Commissioning authority.

11. "Operational Performance Test (OPT)" - Verification of proper startup of all equipment and systems to be commissioned is listed under Prefunctional Tests. These tests are to be described in detail in the commissioning plan.

12. "Sampling" - Operational or Functional testing only a fraction of the total number of identical or near identical pieces of equipment. Generally not allowed on this project see individual division specifications.

B. The following are common abbreviations used in the Specifications and in the Commissioning Plan.

1. A/E: Architect and design engineers

2. CA: Commissioning authority

3. CC: Controls Contractor

4. CM: Construction Manager (the Owner's representative)
5. Cx: Commissioning
6. Cx Plan: Commissioning Plan document
7. EC: Electrical Contractor
8. FIV: Field Installation Verification
9. FPT: Functional Performance Test
10. GC: General Contractor (Prime)
11. MC: Mechanical Contractor
12. OPT: Operational Performance Test
13. PFT: Prefunctional Test (FIV & OPT)
14. PM: Project Manager (of the Owner)
15. Subs: Subcontractors to General
16. TAB: Test and Balance Contractor

1.3 REFERENCES

A. AHSRAE Guideline "0" for the Commissioning Process

B. NEBB Building Systems Commissioning Procedural Manual latest addition

1.4 COMMISSIONED EQUIPMENT AND SYSTEMS

A. Fire Suppression Systems - Section 21

B. HVAC Systems, Controls and TAB - Section 23

C. Electrical Systems - Section 26

D. Communications Systems - Section 27

E. Electronic Safety and Security Systems - Section 28

1.5 COORDINATION

A. Commissioning Team: The members of the commissioning team consist of the Commissioning authority (CA), the Project Manager (PM), the designated representative of the Owner's Construction Management firm (CM), the General Contractor (GC or Contractor), the architect and design engineers, the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing Subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.

B. Management: The CA is hired by the Owner. The CA directs and coordinates the commissioning activities and the reports to the Owner. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

C. Scheduling: The CA will work with the CM according to established protocols to schedule the commissioning activities. The CA will provide sufficient notice to the CM for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process. The CA will provide the initial schedule of primary commissioning events at the commissioning scoping meeting. As construction progresses more detailed schedules are developed by the CA.

1.6 COMMISSIONING PROCESS

A. Commissioning Plan: A Commissioning Plan shall be developed by the CA and will be provided at the initial commissioning kickoff meeting. The commissioning plan provides guidance in the execution of the commissioning process. The Cx Plan is a living document and will continue to evolve and expand as the project progresses. The final commissioning plan is binding on the Contractor. The Specifications will take precedence over the Commissioning Plan.

B. Commissioning Process by Project Phase: The following narrative provides a brief overview of the typical commissioning tasks during design and construction and the general order in which they occur.

1. Pre-Design phase commissioning is comprised of review of the Owners Project Requirements document and a commissioning focused review of the schematic design.

2. Design phase commissioning is comprised of a commissioning focused design and specifications review of 95% design development contract documents.

3. Construction phase commissioning begins with a commissioning kickoff meeting conducted by the CA where the commissioning process is reviewed with the commissioning team members.

4. Additional meetings will be required throughout construction, scheduled by the CA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.

5. Equipment documentation is submitted to the CA during normal submittals, including detailed startup procedures.

6. The CA works with the Subs in developing startup plans and startup documentation formats, including approving Subcontractor and vendor forms, or by providing the Subs with FIV and OPT checklists as a reference of items to be verified by the commissioning team.

7. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with FIV and OPT checklists being completed before functional performance testing. The Contractors provide FIV checks and inspections and documents the activities on an approved check sheet. The CA may provide field installation inspections for random systems and subsystems covered in the scope of work for this project and provide an installation observation report to the General Contractor/Construction Manager. The report shall cover any installation deficiencies from plans and specifications.

8. The Subs perform startup and initial checkout. The CA documents that the startup was completed according to the approved plans.

9. The CA develops specific equipment and system functional performance test procedures to show system functionality. FPT tests are performed by the Contractors.

10. Deficiencies in material, installation, setup, operation or system functionality are corrected at the Sub's expense and the system retested.

11. The CA reviews the O&M documentation for completeness.

12. Commissioning is completed before substantial completion.

13. The CA reviews, pre-approves and coordinates the training provided by the Subs and verifies that is was completed.

14. The CA issues a final Commissioning Report.

1.7 RESPONSIBILITIES

A. The responsibilities of the commissioning team members for the commissioning process are provided in this section. The responsibilities of the Subcontractors, vendors and third tier Subcontractors are listed in the separate Division specifications. See related sections above. The commissioning team is comprised of the Owner, Architect, Engineers of Record, Construction Manager, General Contractor, Subcontractors, vendors, and third tier Subcontractors of each Division included in the scope of work.

B. All Commissioning Team Parties

1. Assist in the development of the Final Commissioning Plan.

2. Follow and implement the Final Commissioning Plan.

3. Attend commissioning meetings as necessary.

C. Owner's Project Manager (PM)

1. Construction and Acceptance Phase:

    a. Manage the contract of the A/E and of the GC.
    b. Act as final authority on all Commissioning Issue Log and Field Observation resolutions
    c. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions according to the Commissioning Plan.
    d. Provide final approval for the completion of the commissioning work.

2. Warranty Period:

    a. Ensure that any seasonal or deferred testing and any deficiency issues are addressed and all warranty period commissioning activities are facilitated.

D. Architect (of A/E)

1. Construction and Acceptance Phase:

    a. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted
    b. Provide any design narrative documentation requested by the CA.
    c. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
    d. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.

2. Warranty Period:

    a. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.

E. Designers/Engineers (of the A/E)

1. Construction and Acceptance Phase:

    a. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted.
    b. Provide any design narrative and sequences documentation requested by the CA. The designers shall assist (along with the Contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
    c. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
    d. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
    e. Provide a Design intent presentation at the training sessions for the Owner's personnel.

2. Warranty Period:

   a. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.

F. Commissioning Authority (CA)

1. The CA is not responsible for design concept, design, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CA may assist with problem-solving, non-conformance or deficiencies, but ultimately that responsibility resides with the General Contractor and the A/E. The primary role of the CA is to develop and coordinate the execution of a testing plan, observe and document performance that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents.

2. Construction and Acceptance Phase:

   a. Coordinates and directs the commissioning activities.
   b. Revise as necessary the Commissioning Plan, check sheets or performance tests.
   c. Conduct commissioning meetings as necessary.
   d. Perform site inspections and create observation reports.
   e. Create and manage the Cx Issue Log. Manage all issues to their final resolution.
   f. Review and comment on Contractor submittals.
   g. Review and approve the format and content of FIV and OPT tests and checklists.
   h. Create and distribute FPT tests and criteria.
   i. Validate system startup tests performed by Contractor by verifying startup procedures or by observing startup tests.
   j. Review TAB execution plan.
   k. Perform complete point-to-point control system checkout.
   l. Review all TAB readings by spot testing reading repeatability on a sampling basis.
   m. Analyze any functional performance trend logs and monitoring data to verify performance.
   n. Review all O&M manuals of equipment and systems included in the commissioning scope.
   o. Assist and coordinate training materials and training agendas.
   p. Provide a final Commissioning Report.

3. Warranty Period:

   a. Perform a warranty site visit to determine any unresolved functional issues with all systems in commissioning scope of work.
   b. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.
   c. Coordinate any deferred FPT tests.
   d. Issue Commissioning Report addenda.
   e. Create a re-commissioning manual to be used by the Owner for future re-commissioning efforts and efficient future operations.

G. Construction Manager-Owner's Representative (CM)

1. Construction and Acceptance Phase:

    a. Facilitate the coordination of the commissioning work by the CA, and, with the GC and CA, ensure that commissioning activities are being scheduled into the master schedule.
    b. Review and approve the final Commissioning Plan
    c. Perform the normal review of Contractor submittals.
    d. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CA.
    e. When necessary, observe and witness FIV, OPT and FPT of selected equipment.
    f. Review commissioning progress and deficiency reports.
    g. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning by managing the Commissioning Issue Log.
    h. Assist the CA in coordinating the training of owner personnel.

2. Warranty Period:

    a. Assist the CA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.

H. General Contractor (GC)

1. Construction and Acceptance Phase:

    a. Facilitate the coordination of the commissioning work and commissioning communications between the Owner, Design professionals, CA and all Subcontractors and ensure that commissioning activities are being scheduled into the master schedule.
    b. Include the cost of commissioning in the total contract price.
    c. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CA.
    d. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
    e. Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
    f. Coordinate the training of owner personnel.
    g. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

2. Warranty Period:

    a. Ensure that Subs execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
    b. Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

I. Subcontractors and Vendors

1. Construction and Acceptance Phase:

    a. Provides commissioning work and commissioning communications between the commissioning team for their required commissioning responsibilities.
    b. Include the cost of commissioning in their total contract price.
    c. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
    d. Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
    e. Coordinate the training of owner personnel.
    f. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

2. Warranty Period:

    a. Ensure that Subs execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
    b. Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division Contractor for the equipment being tested.

A. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone Datalogging equipment that may be used by the CA.

B. Datalogging equipment and software required to test equipment will be provided by the CA, but shall not become the property of the Owner.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If the specification does not specify test instrument accuracy the CA shall provide the required data. All equipment shall be calibrated annually according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

A. Kickoff Commissioning Meeting: The CA will schedule, plan and conduct a commissioning kickoff meeting with the entire commissioning team in attendance. Meeting agenda will be distributed to all parties by the CA. Information gathered from this meeting will allow the CA to revise the Draft Commissioning Plan to its "final" version, which will also be distributed to all parties.

B. Miscellaneous Meetings: Other meetings will be planned and conducted by the CA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with Cx team members.

3.2 REPORTING

A. The CA will provide regular reports to the CM or PM, depending on the management structure, with increasing frequency as construction and commissioning progresses. Standard forms are provided and referenced in the Commissioning Plan.

B. The CA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.

C. Testing approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

3.3 SUBMITTALS

A. The CA will provide appropriate Contractors with a specific request for the type of submittal documentation that the CA requires facilitating the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At a minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed startup procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings, user interface graphics for each system, and details of Owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority. All documentation requested by the CA will be included by the Subs in their O&M manual contributions.

B. The Commissioning Authority will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. It is intended that the CA shall provide submittal review after the design professionals have reviewed or approved the submittals. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning Authority will notify the CM, PM or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

C. The CA may request additional design narrative from the A/E and Contractors, depending on the completeness of the design intent documentation and Drawings and Specifications.

D. These submittals to the CA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor.

3.4 FIELD INSTALLATION VERIFICATION AND OPERATIONAL PERFORMANCE TESTS (Pre Functional Testing)

A. The following procedures apply to all equipment and systems to be commissioned.

B. Field Installation Verification (FIV) inspections are performed by various commissioning team members as outlined in the commissioning plan. FIV inspections are intended to verify that all equipment and systems are installed in accordance with the manufacturer's installation requirements and allow all required operation and maintenance access. No sampling strategies are allowed for FIV inspections. FIV inspections for a given system or piece of equipment shall be complete prior to OPT testing.

C. FIV forms and check sheets are created by the Contractor from manufacturer's installation instructions. The CA may provide the check sheets and forms if the Contractor's submitted forms are inadequate. All FIV check sheets and forms shall be approved by the CA prior to their use on the project.

D. All FIV inspections are performed in accordance with the commissioning schedule.

E. Operational Performance Tests (OPT) are startup tests and procedures performed by the startup Contractors as required by the project specifications. The startup Contractor shall perform the startup services and document all pertinent startup information on the OPT check sheet. No sampling strategies are allowed for OPT tests. OPT tests for a given system or piece of equipment shall be complete prior to FPT testing.

F. OPT forms and check sheets are created by the Contractor or vendor from manufacturer's startup instructions. The CA may provide the check sheets and forms if the Contractor's submitted forms are inadequate. All OPT check sheets and forms shall be approved by the CA prior to their use on the project.

G. All OPT tests are performed in accordance with the commissioning schedule.

H. Deficiency Issue Log:

1. The CA shall provide a periodic commissioning issue log clearly listing any deficiencies or areas of concern from any FIV or OPT.

2. The issue log shall be provided to the CM/GC for distribution to the appropriate parties for review, response and action. All actions and results will be listed on the issue log for future reference.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

3.5 PHASED COMMISSIONING

A. The project may require startup and initial checkout to be executed in phases. This phasing will be planned and scheduled in a coordination meeting of the CA, CM, GC and appropriate Subcontractors. Results will be added to the master and commissioning schedule.

3.6 FUNCTIONAL PERFORMANCE TESTING

A. This section applies to all systems and equipment that is to be functional tested in accordance with the commissioning plan.

B. Functional Performance Testing (FPT) Objectives and Scope:

1. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional tests will identify areas of deficient performance so they can be corrected, improving the operation and functionality of the systems.

2. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each mode of operation in the sequences of operation is required. Proper responses to such modes and conditions such as failure mode, normal operating mode, and alarm mode shall also be tested.

C. Development of FPT Test Procedures:

1. Before test procedures are written, the CA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. The Subcontractor or Vendor then performs or executes the FPT and provides the specified verification back to the CA for approval. The CA shall provide a copy of the test procedures to the Subcontractors or Vendors who shall review the tests for feasibility, safety, equipment and warranty protection. The CA may submit the tests to the A/E for review, if requested.

D. FPT Test Methods:

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using an automatic control system's trend log capabilities or by stand-alone dataloggers. The CA may substitute specified methods or require an additional method to be executed, other than what was specified if satisfactory results are not obtained through the specified tests. The CA will determine which method is most appropriate for tests that do not have a method specified.

E. FPT Sampling Methodology:

1. Multiple identical pieces of non-life-safety or otherwise non-critical equipment with identical factory configured control sequences may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference.

F. FPT Coordination and Scheduling:

1. The Subcontractors shall provide sufficient notice to the CA regarding their completion schedule for the startup of all equipment and systems. The CA will schedule functional tests through the CM, GC and affected Subcontractors. The CA shall direct and document the functional testing of all equipment and systems.

2. In general, functional testing is conducted after FIV's and OPT's have been satisfactorily completed. Control systems are sufficiently tested and calibrated before being used to test and verify the function of other equipment and systems. System balancing and testing is completed and system operation is debugged before functional testing is performed. Testing proceeds from components to subsystems to systems.

G. Test Equipment:

1. Refer to "Part 2 - Products" for test equipment requirements.

H. Problem Solving:

I. The CA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Designers, GC, and Subcontractors.

3.7 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation:

1. The CA shall document the results of all functional performance tests using the specific procedural forms developed in the commissioning plan and on the FPT forms.

B. Non-Conformance:

1. The CA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the CM/GC on the standard Commissioning Issue Log.

2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form.

3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues.

4. As tests progress and a deficiency is identified, the CA discusses the issue with the executing Contractor.

    a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:

        1) If the deficiency can be easily and quickly corrected, it shall be the discretion of the CA whether the deficiency shall be immediately corrected for the testing to proceed.
        2) The CA reschedules the test and the test is repeated.

    b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

        1) The deficiency shall be documented on the issue log or the test check sheet with the Sub's response and a copy given to the CM/GC and to the Subcontractor representative assumed to be responsible.
        2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Owner's Project Manager.
        3) The CA documents the resolution process.
        4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CA. The CA reschedules the test and the test is repeated until satisfactory performance is achieved.

5. Failure Due to Manufacturer Defect:

    a. If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance specifications, all identical units may be considered unacceptable.

6. Cost of Retesting:

    a. The cost for the Subcontractor to retest a OPT or FPT, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be per the GC.

b. For a deficiency identified, not related to any prefunctional checklist or startup fault, the CA will direct the retesting of the equipment once at no "charge" to the GC for the CA's time. However, if the test fails for the corrected work the CA's time for a retest will be charged to the GC at the CA's standard rate. This process will be repeated until the system performance is verified.

c. The time for the CA to direct any retesting required because a specific FIV or OPT item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the GC, who may choose to recover costs from the party responsible.

7. The Contractor shall respond in writing to the CA and CM/GC at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning.

8. The CA retains the original non-conformance forms until the end of the project.

9. Any required retesting by any Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime Contractor.

C. Approval:

1. The CA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CA. The CA recommends acceptance of each test to the Owner's representative using a standard form.

3.8 OPERATION AND MAINTENANCE MANUALS

A. Prior to substantial completion, the CA shall review the O&M manuals, documentation and final as-builts for systems that were commissioned to verify compliance with the Specifications. The CA will communicate deficiencies in the manuals to the CM/GC or A/E, as requested. Upon a successful review of the corrections, the CA recommends approval and acceptance of these sections of the O&M manuals to the CM/GC. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

3.9 COMMISSIONING FINAL REPORT

A. The final commissioning report shall include the final Commissioning Plan, Commissioning Specifications, and for each piece of commissioned equipment, the appropriate FIV, OPT and FPT completed check sheets as described in the Commissioning Plan. The report shall also include all Commissioning Issue Logs, Field Observation Reports and relevant commissioning communication.

3.10 TRAINING OF OWNER PERSONNEL

A. The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.

B. The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

1. The CA shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and CA shall decide how rigorous the training should be for each piece of commissioned equipment. The CA shall communicate the results to the Subcontractors and vendors who have training responsibilities.

2. Each Sub and vendor responsible for training will submit a written training plan to the CA for review and approval prior to training. The plan will cover the following elements:

   a. Equipment (included in training)
   b. Intended audience
   c. Location of training
   d. Objectives
   e. Subjects covered (description, duration of discussion, special methods, etc.)
   f. Duration of training on each subject
   g. Instructor for each subject
   h. All training methods shall include a classroom lecture and an actual operational demonstration of startup, operation, shut down and maintenance procedures.
   i. Instructor and qualifications

3. The GC develops an overall training plan and coordinates and schedules, with the Subcontractors and Owner's representative incorporating the training agendas approved by the CA. The CA develops criteria for determining that the training was satisfactorily completed. The CA recommends approval of the training to the CM using a standard form.

3.11 DEFERRED TESTING

A. Seasonal Testing:

1. Seasonal testing pertains to testing under full load conditions during peak heating and peak cooling seasons. Though rare, testing may also be necessary under part load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.

2. Contractors shall correct deficiencies and make adjustments to systems documentation including O&M manuals and as-built drawings applicable to any issues identified or changes made during seasonal testing. The Commissioning Authority shall provide an addendum to the Commissioning Report for any seasonal commissioning that occurs.

B. Unforeseen Deferred Tests:

1. If any check or test cannot be completed due to the building structure, required occupancy condition or seasonal constraints or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests will be conducted in the same manner as the seasonal tests as soon as possible.

END OF SECTION

SECTION 024119 - SELECTIVE DEMOLITION

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. Refer to the FAA Construction Waste Management Requirements for Contracts (3.6.3-22 Dated October 2016)

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 010100 "Summary" for restrictions on the use of the premises, FAA-occupancy requirements, and phasing requirements.
2. Section 010450 "Cutting and Patching" procedures.
3. Section 017419 "Construction Waste Management and Disposal".

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Government ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Government that may be uncovered during demolition remain the property of the Government.

1. Carefully salvage in a manner to prevent damage and promptly return to Government.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection

1.6 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property , for environmental protection, for dust control and noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure FAA's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator, stairs and other egress components of the building.
5. Coordination of FAA's continuing occupancy of portions of existing building and of FAA's partial occupancy of completed Work.

C. Inventory: Submit a list of items to be removed and salvaged and deliver to Government prior to start of demolition.

D. Predemolition Photographs or Video: Submit before Work begins.

E. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

F. Because the building will be occupied with employees during the project, AMP-100 must have copies of all Safety Data Sheets for any chemical to be used.

1.7 FIELD CONDITIONS

A. FAA will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so FAA's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by FAA as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Storage or sale of removed items or materials on-site is not permitted.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by FAA. FAA does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 010100 "Summary of Work".

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. The FAA Project Manager will arrange to shut off indicated services/systems when requested by Contractor.

2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   c. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   d. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Government.

C. Fluorescent lighting, mercury containing devices, and batteries are universal waste and shall be recycled/disposed by the contractor to an appropriate receiving facility.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Section 015000 "Construction Facilities and Temporary Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

4. Cover and protect furniture, furnishings, and equipment that have not been removed.

5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Construction Facilities and Temporary Controls."

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.

4. Maintain adequate ventilation when using cutting torches.

5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

6. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

7. Dispose of demolished items and materials promptly.

B. Reuse of Building Elements: Project has been designed to result in end-of-Project rates for reuse of building elements as follows. Do not demolish building elements beyond what is indicated on Drawings without Architect's approval.

C. Removed and Salvaged Items:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers.

3. Store items in a secure area until delivery to Government.

4. Transport items to FAA's storage area designated by FAA Project Manager.

5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.

2. Store items after cleaning and repairing. Identify contents of containers.

3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

5. Items to be removed and reinstalled include the following:

   a. Existing room identification signs
   b. Existing wall protection including wood guard/bumper rails in the corridors (bid option)
   c. Existing hand rails in the corridors (bid option)
   d. Existing art work and other wall mounted items in the corridors (bid option)
   e. Drawings indicate removal and storage of diffusers, registers and all ceiling attached devices, and also protection of sprinkler heads.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

B. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain FAA's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3. Coordinate first subparagraph below with use of elevators, stairs, or building entries permitted by building manager.

4. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Refer to the FAA Construction Waste Management Requirements for Contracts (3.6.3-22 Dated October 2016)

C. Burning: Do not burn demolished materials.

D. Disposal: Transport demolished materials off FAA's property and legally dispose of them.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.8 REMOVE & RECYCLE

PLAN TO COLLECT AND STORE REMOVED CARPET

A. Requirements for collection, protection, storage of removed carpet to follow:

1. Palletize demolished carpet tile and wrap with plastic. Contractor to provide a storage connex for the removed carpet tile and locate it near the building in the designated contractor staging area.

2. Once the connex is filled with approximately 17 pallets (20,400 sf) coordinate with the project manager on having the carpet tile picked up for recycling.

3. If additional storage area is needed for removed carpet tile, the contractor will be responsible for providing additional connex as needed.

4. Carpet is to be kept out of the weather or damp areas at all times to allow for recycling.

3.9 COORDINATION OF OWNER'S MOVING SERVICES DURING CONSTRUCTION

COORDINATION FOR MOVING SERVICES FOR FURNITURE MOVEMENT FOR SEPARATE PHASES

B. CLARIFICATION OF MOVING SERVICES ROLE AND NOTES FOR CONSTRUCTION DOCUMENTS TO FOLLOW:

1. Existing furniture will not be removed from the project areas during construction.

2. The FAA/AMP-400 Moving Services will be utilized for minor relocation or disassembly of the furniture within the project areas as needed to facilitate construction.

3. All moving or disassembly of furniture must be performed by AMP-400 Moving Services.

4. For the lifting of systems furniture for carpet installation, the flooring subcontractor will be allowed to perform the furniture lifting.

END OF SECTION

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 DEFINITIONS

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

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate 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.

C. 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.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

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

1. Cementitious materials.

2. Admixtures.
3. Steel reinforcement and accessories.
4. Curing compounds.
5. Bonding agents.
6. Adhesives.
7. Joint-filler strips.
8. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A 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."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
3. Revise size of panel in first subparagraph below if required. Panel for slab-on-grade may need to be enlarged if powered riding trowels are used and if it is a portion of the floor slab.
4. Retain subparagraph below if the intention is to make an exception to the default requirement in Section 014000 "Quality Requirements" for demolishing and removing mockups.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1.7 FIELD CONDITIONS

A. 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 40 deg F 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.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 117.

2.2 FORM-FACING MATERIALS

A. 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.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. 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.

2.5 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I , gray.
2. Fly Ash: ASTM C 618, Class F or C.

C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 1N coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch As indicated for concrete mixtures.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C 260/C 260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

F. Water: ASTM C 94/C 94M.

2.6 CONCRETE MIXTURES, GENERAL

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

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and concrete with a w/c ratio below 0.50.

2.7 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings and Slabs.

1. Minimum Compressive Strength: As indicated at 28 days.
2. Maximum W/C Ratio: 0.45.
3. Slump Limit:8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

2.8 FABRICATING REINFORCEMENT

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

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

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

D. Construct 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.

E. 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.

F. 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.

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

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

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

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

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

3.2 EMBEDDED ITEM INSTALLATION

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.

B. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.3 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 50 deg F 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 support 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 are not 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 Architect.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting 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 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.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. 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 seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. 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.

E. 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. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Maintain reinforcement in position on chairs during concrete placement.

3. Screed slab surfaces with a straightedge and strike off to correct elevations.

4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.6 MISCELLANEOUS CONCRETE ITEM INSTALLATION

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.

3.7 CONCRETE PROTECTING AND CURING

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

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with any of 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 12-inch lap over adjacent absorptive covers.
d. 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 12 inches, 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.

3.8 CONCRETE SURFACE REPAIRS.

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.9 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

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

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

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    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.
    b. 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.
    c. 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.
    d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
    e. Compression Test Specimens: ASTM C 31/C 31M.
    f. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    g. 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.

h. Strength of each concrete mixture will be 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 500 psi.

i. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 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, 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.

j. 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 Architect. 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 Architect.

k. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

l. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Ties and anchors.
5. Embedded flashing.
6. Miscellaneous masonry accessories.

1.2 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

C. Samples for Verification: For each type and color of the following:

1. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties.
b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include name of manufacturer, brand name, and type.

3. Mortar admixtures.

4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.

5. Grout mixes. Include description of type and proportions of ingredients.

6. Reinforcing bars.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.

2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.

3. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: 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 TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet vertically and horizontally of a walking surface.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

2. Provide square-edged units for outside corners unless otherwise indicated.

3. Provide bullnose units for outside corners at door heads and jambs when CMU is exposed.

B. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.

2. Density Classification: Lightweight or Normal weight.

3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Cement: ASTM C 1329/C 1329M.

E. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

F. Aggregate for Grout: ASTM C 404.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

H. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

2.8 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime or mortar cement mortar unless otherwise indicated.

3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For reinforced masonry, use Type S.

2. For exterior, above-grade, nonload-bearing walls, use Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.

2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.

3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

2. Verify that reinforcing dowels are properly placed.

3. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build masonry construction to full thickness shown.

B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

C. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing adjacent masonry.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.

3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.

3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.

5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2-inch maximum.

7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond ; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

H. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.

2. Bed webs in mortar in grouted masonry, including starting course on footings.

3. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush where indicated to receive cavity wall insulation or air barriers unless otherwise indicated.

3.6 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.7 REINFORCED UNIT MASONRY INSTALLATION

A. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than 60 inches.

3.8 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to the International Building Code.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

D. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.9 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.

3. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.10 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.

2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste.

3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 047200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast stone.

a. Cast stone cap.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for installing cast stone units in unit masonry.

1.2 SUBMITTALS

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

1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include building elevations showing layout of units and locations of joints and anchors.

C. Samples for Verification:

1. For each color and texture of cast stone required, 10 inches square in size.

D. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C 1364, including test for resistance to freezing and thawing.

1. Provide test reports based on testing within previous two years.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units.

B. Source Limitations for Cast Stone: Obtain cast stone units through single source from single manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

B. Pack, handle, and ship cast stone units in suitable packs or pallets.

1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.

2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.5 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 CAST STONE MATERIALS

A. General: Comply with ASTM C 1364 and the following:

B. Portland Cement: ASTM C 150, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C 114. Provide natural color or white cement as required to produce cast stone color indicated.

C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33; gradation and colors as needed to produce required cast stone textures and colors.

D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation and colors as needed to produce required cast stone textures and colors.

E. 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.

F. Admixtures: Use only admixtures specified or approved in writing by Architect.

1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.

2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.

3. Retain option in first subparagraph below if air entrainment is required for exterior units (for freeze-thaw resistance).

4. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.

G. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast stone material.

1. Galvanized Coating: ASTM A 767/A 767M.

2.2 CAST STONE UNITS

A. Provide cast stone units complying with ASTM C 1364 using either the vibrant dry tamp or wet-cast method.

1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.

B. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.

C. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.

2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.

3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.

4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

D. Cure units as follows:

1. Cure units in enclosed moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.

2. Keep units damp and continue curing to comply with one of the following:

a. No fewer than six days at mean daily temperature of 60 deg F or above.

E. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

F. Colors and Textures: To match color and texture of existing cast stone window sills.

2.3 MORTAR MATERIALS

A. Provide mortar materials that comply with Division 04 Section "Unit Masonry."

2.4 MORTAR MIXES

A. Comply with requirements in Division 04 Section "Unit Masonry" for mortar mixes.

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 work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR

A. Install cast stone units to comply with requirements in Division 04 Section "Unit Masonry."

B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

C. Rake out top and face joints for installation of sealant with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

D. Tool unexposed exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Set units in full bed of mortar.

1. Set Units with joints 1/4 to 3/8 inch (6 to 10 mm) wide unless otherwise indicated.

2. Keep head joints open to receive sealant.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.4 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.

1. Remove mortar fins and smears before tooling joints.
2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.

3. Delete first two subparagraphs below if no cleaners are allowed or specified in Part 2.

4. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

5. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.

6. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.

END OF SECTION

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel framing and supports for equipment.

2. Metal bollards.

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

1. Anchor bolts and steel pipe sleeves indicated to be cast into concrete or built into unit masonry.

2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions 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. Product Data: For the following:

1. Metal bollards.

PART 2 - PRODUCTS

2.1 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 1/32 inch 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 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.

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, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.2 METAL BOLLARDS

A. Fabricate metal bollards as indicated in drawings. Paint yellow to match existing adjacent bollards.

2.3 GENERAL FINISH REQUIREMENTS

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.

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.

3.2 INSTALLATION OF 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 shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 REPAIRS

A. Touchup Painting:

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

    a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

END OF SECTION

SECTION 061000 - ROUGH CARPENTRY

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. Wood furring.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC 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 indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.

3. Revise subparagraph below if rough lumber is acceptable for all work.

4. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, 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 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.

2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all rough carpentry unless otherwise indicated.

1. Concealed blocking.

2.3 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

2. Furring.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of the following species:

1. Hem-fir (north); NLGA.

2. Mixed southern pine or southern pine; SPIB.

3. Spruce-pine-fir; NLGA.

4. Hem-fir; WCLIB or WWPA.

5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

6. Western woods includes hem-fir and spruce-pine-fir (south).

7. Western woods; WCLIB or WWPA.

8. Northern species includes hem-fir (north) and spruce-pine-fir.

9. Northern species; NLGA.

10. Eastern softwoods includes spruce-pine-fir (south).

11. Eastern softwoods; NeLMA.

C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine or southern pine; No. 2 grade; SPIB.

2. Hem-fir or hem-fir (north); Standard or No. 3 Common grade; NLGA, WCLIB, or WWPA.

3. Spruce-pine-fir (south) or spruce-pine-fir; Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.

4. Three species groups below include last two above; if retaining any of three below, delete one of, or both, above to eliminate duplication.

5. Eastern softwoods; No. 2 Common grade; NeLMA.

6. Northern species; No. 2 Common grade; NLGA.

7. Western woods; Standard or No. 3 Common grade; WCLIB or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.4 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

C. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).

2. ICC-ES evaluation report for fastener.

E. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber blanket insulation.

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

1.2 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20-25 percent.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

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. CertainTeed Corporation.
b. Guardian Building Products, Inc.
c. Johns Manville; a Berkshire Hathaway company.
d. Knauf Insulation.
e. Owens Corning.

C. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:

1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.

2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

3. Interior radiation control coating system is a proprietary coating available in either a solvent- or water-based formulation. If retaining solvent-based coating, verify its acceptability with local air quality-control board. Specify products by name and description. See manufacturers' literature for proper use. See Evaluations.

4. Products below may exceed 0.25 surface emittance value when applied to porous materials such as brick and concrete masonry units. Verify value with manufacturer.

5. Retain materials required for Project. This article includes vapor retarders applied separately from insulation. Facings that act as vapor retarders are specified with insulation in articles above. No manufacturers and products are listed for polyethylene vapor retarders in first paragraph below because they are readily available from many manufacturers.

2.2 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

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 or comparable product by one of the following:

a. AGM Industries, Inc.
b. Gemco.

3. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

4. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

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 or comparable product by one of the following:

a. Gemco.

3. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.

4. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

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 or comparable product by one of the following:

a. AGM Industries, Inc.
b. Gemco.

3. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

a. Crawl spaces.
b. Ceiling plenums.
c. Attic spaces.

D. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

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. AGM Industries, Inc.
b. Gemco.

2.3 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..

2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

D. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This installer shall also provide fire-resistive joint systems specified in Section 078446 "Fire-Resistive Joint Systems." Installer shall be responsible for design and selection of all systems.

B. Related Sections:

1. Section 078446 "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: For each condition anticipated.

C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
b. Classification markings on penetration firestopping correspond to designations listed by the following:

1) UL in its "Fire Resistance Directory."

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.2 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated. All firestopping is done by the firestop installer approved in Div 07.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION - 078413

SECTION 078446 – FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install tested and listed firestopping systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls and partitions, including through-penetrations and construction joints and gaps.

1. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents.

2. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; do not allow firestopping material to interfere with the required movement of the joint.

3. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof or floor deck above and at the intersection of shaft assemblies and adjoining fire resistance rated assemblies.

1.2 RELATED SECTIONS

A. The following sections contain references to firestopping materials and procedures to be provided or performed by the Firestopping installer:

1. Section 283111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls.

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.

C. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.

2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. See Section 078413 - Penetration Firestopping, Paragraph 1.1, A, 1- Installer shall be responsible for design and selection of all systems.

B. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

C. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

D. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.

2. Apply fill materials so they contact and adhere to substrates formed by joints.

3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor's name, address, and phone number.

3. Designation of applicable testing agency.

4. Date of installation.

5. Manufacturer's name.

6. Installer's name.

3.5 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION - 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.

2. Latex joint sealants.

B. Related Sections:

1. Section 092900 "Gypsum Board" for sealing perimeter joints.

1.2 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.

2. Joint-sealant manufacturer and product name.

3. Joint-sealant formulation.

4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

1.5 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When joint substrates are wet.

2. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

3. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.6 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.

2. Disintegration of joint substrates from natural causes exceeding design specifications.

3. Mechanical damage caused by individuals, tools, or other outside agents.

4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

B. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

2.3 URETHANE JOINT SEALANTS

A. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use T.

B. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

2.4 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.5 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

   a. Concrete.
   b. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

   a. Metal.
   b. Glass.
   c. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

   1. Do not leave gaps between ends of sealant backings.

   2. Do not stretch, twist, puncture, or tear sealant backings.

   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

   1. Place sealants so they directly contact and fully wet joint substrates.

   2. Completely fill recesses in each joint configuration.

   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Retain one or more of three subparagraphs below to suit joint configurations required for Project. First subparagraph makes concave configuration the default requirement; second and third subparagraphs require that other configurations be indicated on Drawings. Revise if one of the latter two configurations is the default requirement.

4. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.

a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

a. Isolation joints in cast-in-place concrete slabs.
b. Control and expansion joints in tile flooring.
c. Other joints as indicated.

2. Urethane Joint Sealant: Multicomponent, nonsag, traffic grade, Class 25.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
c. Other joints as indicated.

2. Joint Sealant: Latex, Acrylic based.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Sealant Location:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.
c. Other joints as indicated.

2. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION

SECTION 081416 - FLUSH WOOD DOORS

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. Hollow-core flush wood veneer-faced doors for transparent finish.
2. Fire-rated wood door frames.
3. Factory finishing flush wood doorsand frames.
4. Factory fitting flush wood doors to frames and factory machining for hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Factory-finishing specifications.
5. Fire Resistive Ratings.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door and frame location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Dimensions and locations of mortises and holes for hardware.
7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory primed and application requirements.

C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Special warranties.

1.6 QUALITY ASSURANCE

A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in cardboard cartons, and wrap bundles of doors in plastic sheeting.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during remainder of construction period.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors and frames that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Delamination of veneer.
   b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
   c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors and frames.
3. Warranty Period for Solid-Core Exterior Doors: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain flush wood doors and wood paneling from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Wood Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings and temperature-rise limits indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252.

2.3 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Provide certificates from AWI certification program indicating that doors comply with requirements of grades specified.

2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.

1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

2. Comply with NFPA 80 requirements for fire-rated doors.

2.5 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.

1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

2. Finish faces, all four edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Transparent Finish:

1. Architectural Woodwork Standards Grade: Premium.

2.6 FRAME ANCHORS

A. Jamb Anchors:

1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.7 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. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

C. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

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 087100 "Door Hardware."

B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Install frames level, plumb, true, and straight.

1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

2. Anchor frames to anchors or blocking built in or directly attached to substrates.

   a. Secure with countersunk, concealed fasteners and blind nailing.
   b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.

      1) For factory-finished items, use filler matching finish of items being installed.

D. Job-Fitted Doors:

1. Align and fit doors in frames with uniform clearances and bevels as indicated below.

   a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.

2. Machine doors for hardware.

3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

4. Clearances:

   a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
   b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
   c. Where threshold is shown or scheduled, provide1/4 inch from bottom of door to top of threshold unless otherwise indicated.
   d. Comply with NFPA 80 for fire-rated doors.

5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.

6. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. 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

SECTION 083113 - ACCESS DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Access doors.

1.2 RELATED SECTIONS

A. Section 092900 - Gypsum Board

B. Section 095113 - Acoustical Panel Ceilings.

1.3 SUBMITTALS

A. Comply with Section 013300 - Submittals.

B. Product Data: Submit manufacturer's product data, including installation instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials indoors in a clean, dry area in accordance with manufacturer's instructions.

C. Handling: Protect materials and finishes from damage during handling and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis of design The Williams Bros Corporation of America. Toll Free (800) 255-5515. Toll Free Fax (800) 822- 5001. Phone (540) 636-4444. Fax (540) 636-4455. Web Site www.wbdoors.com. info@wbdoors.com

2.2 ACCESS DOORS FOR DRYWALL

A. Access Doors: Basis of design WB-DW 400 Series for Drywall Access Door.

B. Door: 14 gauge steel.

C. Return Frame: 16 gauge steel. Perforated flange 1 inch wide of 24 gauge satin coated galvanized steel for mounting.

D. Hinges: Fully-concealed. Opens 170 degrees. On long side of door. Number of hinges varies with size of door.

E. Latches: Flush, stainless steel cam-operated with screwdriver. Positioned opposite hinge and at top and bottom on larger sizes.

F. Finish: Primed white baked enamel, paintable surface

G. Cylinder Lock: Keyed alike with 2 keys per lock. Cylinders to be verified with and provided by Owner.

H. Screws: Tamper-proof.

I. Size: 15" x 15".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive access doors. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

3.2 INSTALLATION

A. Install access doors in accordance with manufacturer's instructions at locations indicated on the drawings.

B. Install access doors plumb, level, square, rigid, without warp or rack.

C. Provide proper support for frames.

D. Anchor frames securely in place.

E. Use manufacturer's supplied hardware.

F. Replace defective or damaged doors or other components as directed by Architect.

3.3 ADJUSTING

A. Adjust access doors and latches for smooth operation without binding.

B. Inspect and adjust locks to operate properly.

C. Touch-up marred finishes with manufacturer supplied paint.

3.4 CLEANING

A. Clean surfaces in accordance with manufacturer's instructions.

B. Do not use abrasive cleaners.

3.5 PROTECTION

A. Protect access doors and finish from damage during construction.

END OF SECTION

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:

   a. Swinging doors.

2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

B. Related Requirements:
1. Astragals provided as part of labeled fire-rated assemblies and for door silencers provided as part of hollow-metal frames.
2. Section 083113 "Access Doors and Frames" for access door hardware, including cylinders.
3. Access control devices installed at door openings and provided as part of a security system.
4. Section 283111 "Digital, Addressable Fire-Alarm System" for connections to building fire-alarm system.

1.2 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, and access control with Owner's security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Conference participants shall include Installer's Architectural Hardware Consultant and Owner's security consultant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For electrified door hardware.

1. Include diagrams for power, signal, and control wiring.
2. Include details of interface of electrified door hardware and building safety and security systems.
3. Operational Narrative: Describe the operation of doors controlled by electrified door hardware.

C. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
3. Content: Include the following information:

a. Identification number, location, hand, fire rating, size, and material of each door and frame.
b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
e. Fastenings and other installation information.
f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
g. Mounting locations for door hardware.
h. List of related door devices specified in other Sections for each door and frame.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of electrified door hardware.

1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

B. Schedules: Final door hardware.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware schedule.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

C. Source Limitations: Obtain each type of door hardware from a single manufacturer.

1. Provide electrified door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to Authorities Having Jurisdiction are acceptable.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:

a. Exit Devices: Two years from date of Substantial Completion.
b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of door hardware from single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is 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.

B. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design" .

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:

a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

2.3 SCHEDULED DOOR HARDWARE

A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.

1. Door hardware is scheduled in an attachment.

2.4 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

1. Exterior door hinges and restricted areas in the building shall be security hinges with stud to prevent removal.

2.5 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
2. Deadbolts: Minimum 1-inch bolt throw.

C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Lock Trim:

1. Levers: Forged or Cast.
2. Escutcheons (Roses): Forged or Cast.
3. Dummy Trim: Match lever lock trim and escutcheons.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.

F. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.

2.6 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

2.7 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.

1. Core Type: Interchangeable.

C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.8 CYLINDER GUARDS AT EXTERIOR ALUMINUM DOORS

A. Cylinder Guards:Hardened steel collar installed to protect the cylinder. It has a tapered shape which offers a poor grip surface for prying or twisting attempts. The guard is held in place by a hardened steel retainer plate.

2.9 KEYING

A. Keying System: All keying is accomplished by FAA Staff. Deliver all permanent cross-referenced cores to the Owner for keying.

2.10 OPERATING TRIM

A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.

2.11 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.

B. Astragals: BHMA A156.22.

2.12 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.13 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16.

2.14 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

2.15 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

B. Maximum Air Leakage: When tested according to ASTM E 283 with tested pressure differential of 0.3-inch wg, as follows:

1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.
2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
3. Gasketing on Double Doors: 0.50 cfm per foot of door opening.

2.16 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.17 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

2.18 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:

a. Wood or Machine Screws: For the following:

1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.
2) Strike plates to frames.
3) Closers to doors and frames.

b. Steel Through Bolts: For the following unless door blocking is provided:

1) Closers to doors and frames.
2) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.19 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. 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 the 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine 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 of the Work.

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 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.

E. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Furnish permanent cores to Owner for installation.

F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, in equipment room. Verify location with Architect.

1. Configuration: Provide one power supply for each door opening with electrified door hardware.

G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain door hardware

B.

C.

3.9 DOOR HARDWARE SCHEDULE

A. See Schedule Below:

SET 1.0 (STOREROOM DOOR - SINGLE INTERIOR DOOR)

DOOR: B01A, B14A, 188AA, 110AA, 154A, 290AA, 214A, 263AA, 376AA, 315A, 302A

3 HINGE (SIZE PER SPEC, NRP AS APPLICABLE)
1 STOREROOM, MORTISE LOCKSET , EXTERIOR DEADLOCKING LATCH, INTERIOR EXIT DEVICE.
1 REMOVABLE CORE MATCH FACILITY KEYING
1 SURFACE CLOSER
1 WALL / FLOOR STOP
1 GASKETING SMOKE/SOUND

OPERATION:

1. LATCHBOLT RETRACTED BY KEY OUTSIDE OR BY OPERATING INSIDE EXIT DEVICE.
2. OUTSIDE LEVER IS ALWAYS INOPERATIVE.
3. INSIDE EXIT DEVICE IS ALWAYS FREE FOR IMMEDIATE EGRESS.

END OF SECTION

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

B. Horizontal Deflection: For composite wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft..

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for steel unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C 645.

1. Steel Studs and Tracks:

a. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
b. Depth: As indicated on Drawings.

2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C 645 steel studs and tracks.

a. Minimum Base-Steel Thickness: As required by horizontal deflection performance requirements.
b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Steel Thickness: 0.0269 inch.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC58 or AC308 as appropriate for the substrate.

a. Uses: Securing hangers to structure.

b. Type: Torque-controlled, expansion anchor.
c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.

1. Depth: 2-1/2 inches.

E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226/D 226M, Type I (No. 15 asphalt felt), nonperforated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: As required by horizontal deflection performance requirements unless otherwise indicated.

2. Multilayer Application: As required by horizontal deflection performance requirements unless otherwise indicated.

3. Tile Backing Panels: As required by horizontal deflection performance requirements unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches o.c.

2. Carrying Channels (Main Runners): 48 inches o.c.

3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.

4. Do not attach hangers to steel roof deck.

5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.

7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

SECTION 092900 - GYPSUM BOARD

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. Interior gypsum board.

2. Tile backing panels.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING

A. 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.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 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. Ceiling and 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."

2.2 GYPSUM BOARD, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. 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 Board, Type X: ASTM C 1396/C 1396M.

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 by one of the following:

   a. American Gypsum.
   b. CertainTeed Corporation.
   c. Continental Building Products, LLC.
   d. Georgia-Pacific Building Products.
   e. National Gypsum Company.
   f. PABCO Gypsum.
   g. Temple-Inland Building Products by Georgia-Pacific.
   h. USG.

3. Thickness: 5/8 inch .

4. Long Edges: Tapered.

B. Gypsum Ceiling Board: ASTM C 1396/C 1396M.

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 by one of the following:

    a. American Gypsum.
    b. CertainTeed Corporation.
    c. Continental Building Products, LLC.
    d. Georgia-Pacific Building Products.
    e. National Gypsum Company.
    f. PABCO Gypsum.
    g. Temple-Inland Building Products by Georgia-Pacific.
    h. USG.

3. Thickness: 1/2 inch.

4. Long Edges: Tapered.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet Plastic Paper-faced galvanized-steel sheet.

2. Shapes:

    a. Cornerbead.
    b. L-Bead: L-shaped; exposed long flange receives joint compound.
    c. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    d. Expansion (control) joint.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

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 products by one of the following:

    a. Fry Reglet Corporation.
    b. Gordon, Inc.
    c. Pittcon Industries.

3. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 , Alloy 6063-T5.

4. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

2. 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 drying-type, all-purpose compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.

4. Finish Coat: For third coat, use drying-type, all-purpose compound.

5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. 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. I Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

D. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

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 by one of the following:

a. Accumetric LLC.
b. Grabber Construction Products.
c. Hilti, Inc.
d. Pecora Corporation.
e. Specified Technologies, Inc.
f. United States Gypsum Company.

3. Sealant shall have a VOC content of 250 g/L or less.

4. Sealant 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."

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 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. 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.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. 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.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. 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. in area.

2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 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.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: As indicated on Drawings.

2. Ceiling Type: Ceiling surfaces.

B. 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) 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.

3.4 APPLYING TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

B. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.

C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING 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. Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216. Joints in fire-rated and/or sound-rated ceiling and walls shall be constructed to maintain the fire and/or sound rating. Submit joint shop drawings for approval and install joints as follows:

1. Install control joints where a partition wall, or ceiling traverses a construction joint (expansion, seismic, or building control element) in the base building structure.

2. Install control joints where a wall or partition runs in an uninterrupted straight plane exceeding 30 linear feet.

3. Install control joints in interior ceilings with a perimeter relief so that linear dimensions between control joints do not exceed 30 feet.

4. Install control joints in interior ceilings without perimeter relief so that linear dimensions between control joints do not exceed 30 feet.

5. Install control joints in exterior ceilings and soffits so that linear dimensions between control joints do not exceed 30 feet.

6. Install control joints or intermediate blocking where ceiling framing members change direction.

7. In addition to the above, install control joints where specified by the architect or designer as a design accent or architectural feature.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.

2. L-Bead: Use where indicated.

3. U-Bead: Use at exposed panel edges.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 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 C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.

2. Level 2: Panels that are substrate for tile.

3. Level 3 is suitable for surfaces receiving medium- or heavy-textured finishes before painting or heavy wallcoverings where lighting conditions are not critical.

4. Level 4 is suitable for surfaces receiving light-textured finishes, wallcoverings, and flat paints. It is generally the standard exposed finish. Gloss and semigloss enamel paints are not usually recommended over this level of finish. ASTM C 840 requires application of "drywall primer" on surfaces before final decoration. Specify priming of gypsum board surfaces in Section 099123 "Interior Painting."

5. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

a. Primer and its application to surfaces are specified in Section 099123 "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.

3.7 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

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

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 acoustical panels and exposed suspension systems for interior ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

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. 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 6-inch- square Samples of each type, color, pattern, and texture.

2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

3. Clips: Full-size hold-down and seismic clips.

1.5 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. Minimum Drawing Scale: 1/4 inch = 1 foot .

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes 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. 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.

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. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

C. 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: 450 or less.

D. 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, ACP1

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:

1. Armstrong World Industries, Inc.

B. Acoustical Panel Standard: Provide manufacturer's standard Ultima High NRC panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 75 percent.

D. Classification: Provide panels as followsType and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face.

2. Pattern: E (lightly textured).

E. Color: White.

F. Light Reflectance (LR): Not less than .87.

G. Ceiling Attenuation Class (CAC): Not less than 35.

H. Noise Reduction Coefficient (NRC): Not less than 0.80.

I. Edge/Joint Detail: Beveled Tegular.

J. Thickness: 3/4 inch .

K. Modular Size: As indicated on Drawings.

L. 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 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEM, GR1

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings:

1. Armstrong World Industries

B. 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.

C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.

1. Structural Classification: Intermediate -duty system.

2. Cap Material: Cold-rolled steel.

3. Cap Finish: Painted white.

2.5 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. 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. 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 0.106-inch- diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

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.

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 requiredto 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. Retain first subparagraph below if applicable and indicate hanger locations on Drawings or by inserts.

5. 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.

6. Retain first subparagraph below if applicable and indicate hanger locations on Drawings or by inserts.

7. 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.

8. Retain one or more of six subparagraphs below that refer to applicable construction types.

9. Revise first subparagraph if power-actuated fasteners are not allowed. Also, revise if attaching to permanent metal forms or the floor deck is permitted by the structural engineer and authorities having jurisdiction.

10. 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.

11. 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.

12. Do not attach hangers to steel deck tabs.

13. Retain first subparagraph below unless attaching to the roof deck is permitted by the structural engineer and authorities having jurisdiction. Revise if structural members are spaced too far apart for hangers and another method is required. For alternatives that may need to be indicated on Drawings, consult Project's structural engineer.

14. Do not attach hangers to steel roof deck. Attach hangers to structural members.

15. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

16. 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 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.

3. Revise or delete subparagraph below if exposed fasteners are allowed.

4. 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 axis of space.

2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

3. 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.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 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

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

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. Thermoset-rubber base.

2. Vinyl molding accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.4 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 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

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 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 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 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE, RB1

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Johnsonite; A Tarkett Company.

B. 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 resilient floor coverings or concrete.

C. Thickness: 0.125 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Colors: As indicated in the Material Legend in the Drawings.

I. Profile and Dimensions: As indicated.

2.2 VINYL MOLDING ACCESSORY, TS2

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: Johnsonite; A Tarkett Company.

B. Description: Vinyl reducer strip for carpet tile.

C. Profile and Dimensions: As indicated on the Flooring Transition Notes in the Drawings.

D. Locations: Provide vinyl molding accessories when transitioning from carpet to concrete.

E. Colors and Patterns: As indicated in the Flooring Transition Legend in the Drawings.

2.3 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.

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. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. 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.

D. 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. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 4 inches 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 4 inches in length.

    a. 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 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. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 096813 - TILE CARPETING

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. Modular carpet tile.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.

2. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet tile 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.

1.4 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.

B. Samples for Verification: 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. Carpet Tile: Full-size Sample.

2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, 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 tile.

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. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floor covering Installers Association at the Commercial II certification level.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Carpet and Rug Institute's CRI 104.

1.10 FIELD CONDITIONS

A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles 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 tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.11 WARRANTY

A. 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.
g. Lightfastness.

3. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE, CPT1

A. Color: As indicated by manufacturer's designations.

B. Pattern: Match Architect's samples of tufted, textured loop.

C. Fiber Content: 100 percent solution dyed nylon.

D. Pile Characteristic: Tufted, Textured Loop pile.

E. Density: 6,120 oz./cu. yd..

F. Pile Thickness: 0.1 inches for finished carpet tile.

G. Stitches: 10 inch.

H. Gage: 1/12 inch.

I. Surface Pile Weight: 17oz./sq. yd..

J. Size: 19.69 by 19.69 inches or 24 by 24 inches.

K. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.

L. Performance Characteristics:

1. Appearance Retention Rating: Severe traffic, 3.5 minimum according to ASTM D7330.

2. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).

3. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) according to AATCC 16, Option E.

4. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

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 tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "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 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 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 in writing by adhesive and carpet tile 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 the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

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 1/8 inch wide or wider, and protrusions more than 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 tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: Quarter turn.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns 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. 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.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.

2. Remove yarns that protrude from carpet tile surface.

3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Gypsum board.
2. Galvanized Steel
3. Hot Rolled Steel Type B

1.2 DEFINITIONS

A. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches 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, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.

2. Remove rags and waste from storage areas daily.

1.6 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are 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, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

3. Piping Identification (tags and labels), requirements appear in MEP specifications. Painting of uninsulated piping is included in this section; both painting of piping and piping identification colors shall conform to ASME A13.1.

B. Colors: As indicated on Sheet I-001 Materials Legend, except colors for uninsulated piping which is indicated in this section.

2.3 PRIMERS/SEALERS

A. Primer, Alkali Resistant, Water Based: MPI #3 for concrete.

B. Interior Latex Primer/Sealer: MPI #50 for most surfaces.

2.4 LATEX PAINTS

A. Interior Latex (Eggshell): MPI #52 (Gloss Level 3) for all areas.

B. Interior Latex (Semigloss): MPI #54 (Gloss Level 5) for metal doors and door frames, railings etc.

2.5 DRY FALL COATINGS

A. Dry Fall, Latex, Flat: Pigmented, water-based, emulsion-type, fast-drying coating for use on interior plaster, concrete, gypsum board, primed wood, and metal ceilings

1. Gloss and Sheen Level: Manufacturer’s standard flat finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

E. Paint uninsulated piping. Piping color schedule:

1. Fire quenching fluids; Safety Red

2. Toxic and corrosive fluids; Safety Orange

3. Flammable and oxidizing fluids; Safety Yellow

4. Combustible fluids; Safety Brown

5. Water; Potable, cooling, and boiler feed; Safety Green

6. Compressed Air; Safety Blue

7. User defined piping; four colors as defined in ASME A13.1.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that 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.

2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

E. Primed metal doors and frames: (Semigloss): MPI #54 (Gloss Level 5) for metal doors and door frames, railings etc.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Gypsum Board Substrates:

1. Latex System: MPI INT 9.2A.

    a. Prime Coat: Interior latex primer/sealer.

    b. Intermediate Coat: Interior latex matching topcoat.

    c. Topcoat: Interior latex (Eggshell).

END OF SECTION

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

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 room-identification signs that are directly attached to the building.

1.3 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.4 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.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification 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.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

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. Room-Identification Signs: Full-size Sample.

2. Variable Component Materials: Full-size Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.

3. Full-size Samples, if approved, will be returned to Contractor for use in Project.

E. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.8 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.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Sign TYPE 1B: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

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

   a. Architectural Sign & Graphics, 839 Industrial Drive, Yukon, OK, (405) 354-8829.
   b. Fastsigns, 1404 S. Meridian Avenue, Oklahoma City, OK, (405) 943-3278.

2. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated to backing sheet to produce composite sheet.

   a. Composite-Sheet Thickness: 0.125 inch.
   b. Color(s): Match existing.

3. Sign-Panel Perimeter: Finish edges smooth.

   a. Edge Condition: Square cut.
   b. Corner Condition in Elevation: Rounded to radius indicated.
   c. Color and Font:

      1) Character Font: Helvetica, Arial, or other sans serif font.
      2) Character Case: Upper case only.
      3) Background Color: Match existing.
      4) Character Color: Contrasting color matching existing.
      5) Tactile Signage Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color.

4. Mounting: Six-inch lengths of double-sided foam tape, positioned horizontally, 1/4-inch to 1/2-inch clear from the sides of the panel. Exception: Where a base plate is required, the foam tape will be installed across the full width of the base plate and flush to the top and bottom edges of the base plate.

5. Text and Typeface: Accessible raised characters minimum 1/32 inches and Grade II Braille.

2.3 SIGN MATERIALS

A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

B. 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. (Note: Colors must be an integral part of the plastic or applied to the back surface of a translucent panel; painted sign faces are not acceptable.)

2.4 ACCESSORIES

A. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies 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. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

4. 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.

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.

PART 3 - EXECUTION

3.1 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. Accessibility: Install signs in locations on walls as indicated on Drawings and according to the accessibility standard.

C. Mounting Methods:

1. 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.

3.2 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 Owner.

END OF SECTION

SECTION 211313 - WET PIPE SPRINKLER SYSTEMS

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. Pipes, fittings, and specialties.
2. Valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gauges.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details. Include all information recommended by NFPA 13.

C. Delegated-Design Submittal: Wet pipe sprinkler systems work is a delegated design. Indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer or NICET III or IV Technician responsible for their preparation.

D. All submittals shall be forwarded to the Architect/Engineer for approval before submitting to the AHJ.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and NICET III or IV Technician.

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Welding certificates.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals. Include field test reports, certificates and as-built drawings and calculations.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire hydrant flow test.

   a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET III or IV Technician.

B. Welding Qualifications: Qualify procedures and operators according to current ASME Boiler and Pressure Vessel Code.

1.8 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Architect and Owner no fewer than five days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Architect's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175 psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer or NICET Technician to design wet pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

2. Minimum Density for Automatic-Sprinkler Piping Design shall conform with NFPA 13 requirements.

3. Maximum Protection Area per Sprinkler: According to UL listing and NFPA 13.

D. Seismic Performance: Sprinkler piping is not required to withstand the effects of earthquake motions.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, ; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

D. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

E. Steel Couplings: ASTM A 865/A 865M, threaded.

F. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

G. Malleable- or Ductile-Iron Unions: UL 860.

H. Cast-Iron Flanges: ASME 16.1, Class 125.

I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

K. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 175-psig minimum.
2. Galvanized or Painted Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated or required by NFPA 13, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

L. Steel Pressure-Seal Fittings: Shall not be used.

2.3 LISTED FIRE PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

B. Ball Valves:

1. Standard: UL 1091 except with ball instead of disc.
2. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
3. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
4. Valves NPS 3: Ductile-iron body with grooved ends.

C. Check Valves:

1. Standard: UL 312.
2. Pressure Rating: 250 psig minimum.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

D. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

E. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valves NPS 2 and Smaller:

   a. Valve Type: Ball, butterfly, or OS&Y.
   b. Body Material: Bronze.

c. End Connections: Threaded.

4. Valves NPS 2-1/2 and Larger:

a. Valve Type: Butterfly or OS&Y.
b. Body Material: Cast or ductile iron.
c. End Connections: Flanged, grooved, or wafer.

5. Valve Operation: Integral electrical,, prewired, two-circuit, supervisory switch, visual indicating device. Supervisory switch for normally closed valve shall signal when valve begins to open.

2.4 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: 175 psig minimum.

C. Body Material: Cast or ductile iron.

D. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.5 SPRINKLER PIPING SPECIALTIES

A. Flexible Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose with stainless steel braid for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.6 SPRINKLERS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Sprinkler Finishes: Chrome plated bronze and factory white painted match existing.

D. Special Coatings: corrosion-resistant white paint.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

F. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.
3. Provide for sprinklers in elevator hoistway and machine rooms, at elevations 7' and below, and where indicated on drawings.

G. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. 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 and tamperproof cover that sends supervisory signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

H. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. 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.

2.7 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2 to 4-1/2 inch diameter.

C. Pressure Gage Range: 0 to 250 psig.

D. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Locations and Arrangements: Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. 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.
3. Coordinate layout and installation of piping with other trades. Relocate as required to resolve conflicts.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install sprinkler piping with drains for complete system drainage.

G. Install alarm devices in piping systems.

H. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

I. Fill sprinkler system piping with water.

J. Install sleeves for piping penetrations of walls, ceilings, and floors.

K. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

A. 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.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. 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.

G. 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 or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. 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. Do not use welded joints for galvanized-steel pipe.

I. 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.

J. 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.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 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 and authorities having jurisdiction.

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.

3.4 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.

3.5 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping. according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections in the presence of the Authorities Having Jurisdiction, the Owner, the Commissioning Agent and the Architect/Engineer, after underground system flushing is performed as specified herein. Provide minimum 10 days advance notice of testing:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire alarm tests. Operate as required.
6. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain sprinkler system. .

3.9 PIPING SCHEDULE

A. Standard-pressure, wet pipe sprinkler system, , shall be the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints

3. 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.

4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

6. 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.

7. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

3.10 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.

2. Rooms with Suspended Ceilings: Concealed sprinklers.

3. Wall Mounting: Sidewall sprinklers.

4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as required.

5. Special Applications: Combustible concealed space sprinklers.

6. Match existing.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate, quick response.

2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon, quick response.

3. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; corrosion resistant paint where exposed to acids, chemicals, or other corrosive fumes.

4. Match existing.

END OF SECTION

SECTION 230130.52 - EXISTING HVAC AIR DISTRIBUTION SYSTEM CLEANING

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 cleaning existing HVAC air-distribution equipment, ducts, plenums, and system components.

B. Related Requirements:

1. Section 233113.00 "Metal Ducts" for cleaning newly installed metal ducts.
2. Section 230593.00 "Testing, Adjusting, Balancing for HVAC" for system flow documentation before cleaning and balancing and following cleaning and restoration.
3. Section 233300.00 "Air Duct Accessories" for restoration of opened ducts and plenums with access doors.

1.3 DEFINITIONS

A. ACAC: American Council for Accredited Certification.

B. AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program

C. ASCS: Air systems cleaning specialist.

D. CESB: Council of Engineering and Scientific Specialty Boards.

E. CMI: Certified Microbial Investigator.

F. CMC: Certified Microbial Consultant.

G. CMR: Certified Microbial Remediator.

H. CMRS: Certified Microbial Remediation Supervisor.

I. EMLAP: Environmental Microbiology Laboratory Accreditation Program.

J. IEP: Indoor Environmental Professional.

K. IICRC: Institute of Inspection, Cleaning, and Restoration Certification.

L. NADCA: National Air Duct Cleaners Association.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Cleaning agents
2. Antimicrobial surface treatments .

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For an ASCS.
2. For an IEP.
3. For a CMR and a CMRS.

B. Field Quality-Control Reports:

1. Project's existing conditions.
2. Evaluations and recommendations, including cleanliness verification.
3. Strategies and procedures plan.

1.6 CLOSEOUT SUBMITTALS

A. Post-Project report.

1.7 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.

1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
2. Supervisor Qualifications: Certified as an ASCS by NADCA.

B. IEP Qualifications: CMI who is certified by ACAC and accredited by CESB.

C. IEP Qualifications: CMC who is certified by ACAC and accredited by CESB.

D. CMR Qualifications: Certified by ACAC and accredited by CESB.

E. CMRS Qualifications: Certified by ACAC and accredited by CESB.

F. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

G. Cleaning Conference: Conduct conference at Project site.

1. Review methods and procedures related to HVAC air-distribution system cleaning, including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS

2.1 HVAC CLEANING AGENTS

A. Description:

1. Formulated for each specific soiled coil condition that needs remedy.
2. Will not corrode or tarnish aluminum, copper, or other metals.

2.2 ANTIMICROBIAL SURFACE TREATMENT

A. Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.

1. Formulated to kill and inhibit growth of microorganisms.
2. EPA-registered for use in HVAC systems and for the specific application in which it will be used.
3. Have no residual action after drying, with zero VOC off-gassing.
4. OSHA compliant.
5. Treatment shall dry clear to allow continued visual observation of the treated surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR.

C. Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures. At a minimum, include the following:

1. Supervisor contact information.
2. Work schedule, including location, times, and impact on occupied areas.
3. Methods and materials planned for each HVAC component type.
4. Required support from other trades.
5. Equipment and material storage requirements.
6. Exhaust equipment setup locations.

D. Existing Conditions Report: Prepare a written report that documents existing conditions of the systems and equipment. Include documentation of existing conditions, including inspection results, photo images, laboratory results, and interpretations of the laboratory results by an IEP.

1. Prepare written report listing conditions detrimental to performance of the Work.

E. Proceed with work only after conditions detrimental to performance of the Work have been corrected.

F. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

G. Comply with NADCA ACR, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

H. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.

3.2 CLEANING

A. Comply with NADCA ACR, including items identified as "recommended," "advised," and "suggested."

B. Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.

C. Remove non-adhered substances and deposits from within the HVAC system.

D. Complete cleaning in accordance with Owner-Contractor agreed-upon scope of work.

E. Systems and Components to Be Cleaned: All air-moving and -distribution equipment.

F. Systems and Components to Be Cleaned:

1. Air devices for supply and return air.
2. Air-terminal units and connections.

    a. Flexible connectors.

3. Ductwork:

    a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
    b. Return-air ducts to the air-handling unit.
    c. Exhaust-air ducts.
    d. Transfer ducts.

4. Casings.
5. Duct-mounted coils.
6. Exhaust fans and power ventilators.
7. Filters and filter housings.
8. Gravity ventilators.
9. Air-to-air heat exchangers.

G. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

H. Particulate Collection:

1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

I. Control odors and mist vapors during the cleaning and restoration process.

J. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

K. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

L. Clean all air-distribution devices, registers, grilles, and diffusers.

M. Clean non-adhered substance deposits according to NADCA ACR and the following:

1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
3. Clean evaporator coils, reheat coils, and other airstream components.

N. Air-Distribution Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).

O. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

P. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

    a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
    b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials, such as duct and plenum liners.

2. Cleaning Mineral-Fiber Insulation Components:

   a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR.
   b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
   c. Fibrous materials that become wet shall be discarded and replaced.

Q. Coil Cleaning:

1. See NADCA ACR, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing coil cleaning verification.
2. Coil drain pans shall be subject to NADCA ACR, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
3. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
4. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations.
5. Rinse thoroughly with clean water to remove any latent residues.

R. Application of Antimicrobial Treatment:

1. Apply antimicrobial agents and coatings if active fungal growth is determined by the IEP to be at Condition 2 or Condition 3 status according to IICRC S520, as analyzed by a laboratory accredited by AIHA-LAP with an EMLAP certificate, and with results interpreted by an IEP. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. Apply antimicrobial treatments and coatings after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Microbial remediation shall be performed by a qualified CMR and CMRS.

3.3 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Verification of Coil Cleaning: Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

E. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

F. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.

3.4 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Section 233113 "Metal Ducts."

C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts".

D. Replace damaged insulation according to Section 230713 "Duct Insulation."

E. Ensure that closures do not hinder or alter airflow.

F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

G. Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.

H. Measure air flows through air-distribution system.

I. Measure static-pressure differential across each coil.

3.5 PROJECT CLOSEOUT

A. Post-Project Report:

1. Post-cleaning laboratory results if any.
2. Post-cleaning photo images.
3. Post-cleaning verification summary.

B. Drawings:

1. Deviations of existing system from Owner's record drawings.
2. Location of service openings.

END OF SECTION

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. RPTFE: Reinforced polytetrafluoroethylene.

C. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder-joint connections.
6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
7. ASME B16.34 for flanged and threaded end connections.
8. ASME B31.1 for power piping valves.
9. ASME B31.9 for building services piping valves.

B. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.

2. Hand Lever: For quarter-turn valves smaller than NPS 4.

F. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.

2. Extended operating handles with nonthermal-conductive covering material, and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.

3. Memory stops that are fully adjustable after insulation is applied.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRASS BALL VALVES

A. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

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. A.Y. McDonald Mfg. Co.
    b. American Valve, Inc.
    c. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    d. Bray International, Inc.
    e. Center Line; a Crane Co. brand.
    f. DynaQuip Controls.
    g. FNW; Ferguson Enterprises, Inc.
    h. Hammond Valve.
    i. Jenkins Valves; a Crane Co. brand.
    j. Jomar Valve.
    k. KITZ Corporation.
    l. Lance Valves.
    m. Legend Valve & Fitting, Inc.
    n. Marwin Valve; Richards Industries.
    o. Milwaukee Valve Company.
    p. Red-White Valve Corp.
    q. Siemens Industry, Inc., Building Technologies Division.
    r. Stockham; a Crane Co. brand.
    s. Viega LLC.
    t. WATTS.

2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered.
8. Seats: PTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.

2.4 BRONZE BALL VALVES

A. Bronze Ball Valves, Two Piece with Full Port and Bronze or Brass Trim, Threaded or Soldered Ends:

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. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Crane; a Crane Co. brand.
    c. DynaQuip Controls.
    d. Hammond Valve.
    e. Jenkins Valves; a Crane Co. brand.

f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corp.
i. Stockham; a Crane Co. brand.
j. WATTS.
k. Zurn Industries, LLC.

2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Bronze.
7. Ends: Threaded or soldered.
8. Seats: PTFE.
9. Stem: Bronze.
10. Ball: Chrome-plated brass.
11. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, provide the same types of valves with higher SWP classes or CWP ratings.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Stainless Steel Piping, NPS 2 and Smaller: Threaded ends.
8. For Stainless Steel Piping,NPS 2-1/2 to NPS 4: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Brass bronze ball valves, two piece, with brass trim, full port, and threaded -joint ends.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Brass bronze ball valves, two piece with brass trim, full port, and threaded -joint ends.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Brass bronze ball valves, two piece with brass trim, full port, and threaded -joint ends.

END OF SECTION

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze lift check valves.
2. Bronze swing check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene-propylene-diene monomer.

C. NBR: Nitrile butadiene rubber (also known as "Buna-N").

D. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, press connections, and weld ends.
3. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges for metric standard piping.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast copper solder joint.
6. ASME B16.22 for wrought copper solder joint.
7. ASME B16.51 for press joint.
8. ASME B31.1 for power piping valves.
9. ASME B31.9 for building services piping valves.

B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE LIFT CHECK VALVES

A. Bronze Lift Check Valves with Bronze Disc, Class 125:

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. A.Y. McDonald Mfg. Co.
b. American Valve, Inc.
c. Apollo Valves; a part of Aalberts Integrated Piping Systems.
d. Crane Valves; a Crane Co. brand.
e. Flomatic Valves.
f. Jenkins Valves; a Crane Co. brand.
g. Jomar Valve.
h. Keckley Company.
i. Metraflex Company (The).

j. Milwaukee Valve Company.
k. NIBCO INC.
l. Stockham; a Crane Co. brand.
m. Val-Matic Valve & Manufacturing Corp.
n. Victaulic Company.
o. WATTS.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B61 or ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.4 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

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. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Valves; a Crane Co. brand.
c. Jenkins Valves; a Crane Co. brand.
d. Jomar Valve.
e. Keckley Company.
f. Lance Valves.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Red-White Valve Corp.
j. Shurjoint-Apollo Piping Products USA Inc.
k. Stockham; a Crane Co. brand.
l. Val-Matic Valve & Manufacturing Corp.
m. Victaulic Company.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. Install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.

H. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

I. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends, except where solder-joint or press valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Copper Tubing, except Steam and Steam Condensate Piping: Valve ends may be grooved.
8. Wafer-Type Valves: Flanged connections.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and weight-closure control, Class 125.

3. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
4. Iron, globe, center-guided check valves metal seat, Class 125.
5. Iron, dual-plate check valves with metal seat, .
6. Iron, dual-plate check valves with resilient seat, .

C. CPVC Pipe NPS 2 and Smaller: CPVC ball check valve.

D. PVC Pipe NPS 2 and Smaller: PVC ball check valve.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and -closure control, Class 125.
3. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
4. NPS 2-1/2 to NPS 24: Iron, globe, center-guided check valves with metal seat, Class 125.
5. Iron, single plate-check valves with resilient seat, Class 125.
6. Iron, dual-plate-check valves with metal seat, Class 125.
7. Iron, dual plate check valves with resilient seat, Class 125.

C. CPVC Pipe NPS 2 and Smaller: CPVC ball check valve.

D. PVC Pipe NPS 2 and Smaller: PVC ball check valve.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and -closure control, Class 125.
3. NPS 3 to NPS 12: Iron, grooved-end check valves, 300 CWP.
4. Iron, globe, center-guided check valves with metal seat, Class 125.
5. Iron, single-plate check valves with resilient seat, .
6. Iron, dual-plate check valves with metal seat, .
7. Iron, dual-plate check valves with resilient seat, .

C. CPVC Pipe NPS 2 and Smaller: CPVC ball check valve.

D. PVC Pipe NPS 2 and Smaller: PVC ball check valve.

3.8 LOW-PRESSURE STEAM VALVE SCHEDULE - 15 PSIG OR LESS

A. Pipe NPS 2 and Smaller:

1. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and -closure control, Class 125.

3.9 HIGH-PRESSURE STEAM VALVE SCHEDULE - MORE THAN 15 PSIG

A. Pipe NPS 2 and Smaller:

1. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and -closure control, Class 125.

3.10 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Galvanized Metallic Coatings: Hot-dip galvanized or electro-galvanized.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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. B-line, an Eaton business.
   b. Flex-Strut Inc.
   c. G-Strut.
   d. Haydon Corporation.
   e. MIRO Industries.
   f. Thomas & Betts Corporation; A Member of the ABB Group.
   g. Unistrut; Part of Atkore International.
   h. Wesanco, Inc.

2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

3. Channels: Continuous slotted carbon-steel channel with inturned lips.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Install lateral bracing with pipe hangers and supports to prevent swaying.

F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

I. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

3. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

J. Use instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Carlton Industries, LP.
   d. Champion America.
   e. Craftmark Pipe Markers.
   f. emedco.
   g. Kolbi Pipe Marker Co.
   h. LEM Products Inc.
   i. Marking Services, Inc.
   j. Seton Identification Products; a Brady Corporation company.

2. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.

3. Letter and Background Color: As indicated for specific application under Part 3.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, thick, with predrilled holes for attachment hardware.

2. Letter and Background Color: As indicated for specific application under Part 3.

3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 PIPE LABELS

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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.

2. Brady Corporation.

3. Brimar Industries, Inc.

4. Carlton Industries, LP.

5. Champion America.

6. Craftmark Pipe Markers.

7. emedco.

8. Kolbi Pipe Marker Co.

9. LEM Products Inc.

10. Marking Services Inc.

11. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.

2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.

3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.3 VALVE TAGS

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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.

2. Brady Corporation.

3. Brimar Industries, Inc.

4. Carlton Industries, LP.

5. Champion America.

6. Craftmark Pipe Markers.

7. emedco.

8. Kolbi Pipe Marker Co.

9. LEM Products Inc.

10. Marking Services Inc.

11. Seton Identification Products; a Brady Corporation company.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Sign and Label Colors:

1. White letters on an ANSI Z535.1 safety-blue background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.

2. At access doors, manholes, and similar access points that permit view of concealed piping.

3. Within 3 ft. of equipment items and other points of origination and termination.

4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Chilled-Water Piping: White letters on an ANSI Z535.1 safety-green background.

2. Condenser-Water Piping: White letters on an ANSI Z535.1 safety-green background.

3. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.

4. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.

5. Flammable Fluids: Black letters on an ANSI Z535.1 safety-yellow background.

6. Combustible Fluids: White letters on an ANSI Z535.1 safety-brown background.

3.5 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

   a. Chilled Water: 1-1/2 inches, round.
   b. Condenser Water: 1-1/2 inches, round.
   c. Refrigerant: 1-1/2 inches, round.
   d. Hot Water: 1-1/2 inches, round.
   e. Gas: 1-1/2 inches, round.

2. Valve-Tag Colors:

   a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Balancing Air Systems:

a. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

a. Variable-flow hydronic systems.

3. Testing, adjusting, and balancing existing systems and equipment.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

1.5 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

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 ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. 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.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.

2. Strategies and step-by-step procedures for balancing the systems.

3. Instrumentation to be used.

4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check 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 airflow patterns from the outdoor-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. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.

2. Verify that the system is under static pressure control.

3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point 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 system losses.

4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
    g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.

9. Verify final system conditions as follows:

   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.

2. Check highest vent for adequate pressure.

3. Check flow-control valves for proper position.

4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

5. Verify that motor starters are equipped with properly sized thermal protection.

6. Check that air has been purged from the system.

3.7 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.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.

2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

   a. Measure total water flow.

      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

   b. Measure pump TDH as follows:

      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gage heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

   c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.

7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

8. Mark final settings and verify that all memory stops have been set.

9. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.

2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.

3. Adjust pumps to deliver total design gpm.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.

9. Prior to verifying final system conditions, determine system differential-pressure set point.

10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

11. Mark final settings and verify that memory stops have been set.

12. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

13. Verify that memory stops have been set.

3.8 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.

2. Measure motor voltage and amperage. Compare the values to motor nameplate information.

3. Check the refrigerant charge.

4. Check the condition of filters.

5. Check the condition of coils.

6. Check the operation of the drain pan and condensate-drain trap.

7. Check bearings and other lubricated parts for proper lubrication.

8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.

2. Coils are clean and fins combed.

3. Drain pans are clean.

4. Fans are clean.

5. Bearings and other parts are properly lubricated.

6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

3.9 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating-Water Flow Rate: Plus or minus 10 percent.

4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, 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: Prepare weekly progress 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.

3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to 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; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB specialist.

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 TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, 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.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, 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. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

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 inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor 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 inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.

f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.

e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.

e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

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 inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor 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 inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

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 (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.

d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
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.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.12 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Architect may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.

2. Indoor, exposed supply and outdoor air.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.4 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork 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.

1.5 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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. Certainteed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.

G. Mineral Wool Blanket: Basalt volcanic rock-derived fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C553.

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. Johns Manville; a Berkshire Hathaway company.
b. Owens Corning.
c. ROCKWOOL Technical Insulation.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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. Aeroflex USA.
b. Armacell LLC.
c. Childers Brand; H. B. Fuller Construction Products.
d. Foster Brand; H. B. Fuller Construction Products.
e. K-Flex USA.

C. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.

2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents, unless otherwise approved by the engineer-of-record.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC AND POLYOLEFIN INSULATION

A. Comply with manufacturer's written installation instructions and ASTM C1710.

B. 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.

C. Square and Rectangular Ducts and Plenums:

1. Provide 1/4 inch more per side for a tight, compression fit.

2. Cut sheet insulation with the following dimensions:

a. Width of duct plus 1/4 inch, one piece.
b. Height of duct plus 1/4 inch, plus thickness of insulation, two pieces.
c. Width of duct plus 1/4 inch, plus two times the thickness of insulation, one piece.

3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.

4. Insulation without self-adhering backing:

a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last 1/4 inch where sheets will butt together.
b. Roll sheet down into position.
c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.

5. Insulation with self-adhering backing:

a. Peel back release paper in 6- to 8-inch increments and line up sheet.
b. Press firmly to activate adhesive.
c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
d. Allow 1/4-inch overlap for compression at butt joints.
e. Apply adhesive at the butt joint to seal the two sheets together.

6. Insulate duct brackets following manufacturer's written installation instructions.

D. Circular Ducts:

1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.

2. Cut the sheet to the required size.

3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.

4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "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.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless steel jackets.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, return-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

C. Concealed, round and flat-oval, outdoor-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

D. Concealed, round and flat-oval, exhaust-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

E. Concealed, rectangular, supply-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

F. Concealed, rectangular, return-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

G. Concealed, rectangular, outdoor-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

I. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated ; thickness as required to achieve 2-hour fire rating.

J. Concealed, supply-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

K. Concealed, return-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

L. Concealed, outdoor-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

M. Concealed, exhaust-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

N. Exposed, round and flat-oval, supply-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

O. Exposed, round and flat-oval, return-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

P. Exposed, round and flat-oval, outdoor-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

Q. Exposed, round and flat-oval, exhaust-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.
3. Polyolefin: 1 inch thick.

R. Exposed, rectangular, return-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.
3. Polyolefin: 1 inch thick.

S. Exposed, rectangular, outdoor-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

T. Exposed, rectangular, exhaust-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

U. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated ; thickness as required to achieve 2-hour fire rating.

V. Exposed, supply-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

W. Exposed, return-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

X. Exposed, outdoor-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

Y. Exposed, exhaust-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches thick and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

3.11 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, rectangular, supply-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Glass-Fiber Board: 2 inches thick and 2 lb/cu. ft. nominal density.
3. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

C. Concealed, rectangular, return-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

D. Concealed, supply-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

E. Concealed, return-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

F. Exposed, round and flat-oval, supply-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

G. Exposed, round and flat-oval, return-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

H. Exposed, rectangular, supply-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

I. Exposed, rectangular, return-air duct insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

J. Exposed, supply-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

K. Exposed, return-air plenum insulation is one of the following:

1. Glass-Fiber Blanket: 2 inches and 0.75 lb/cu. ft. nominal density.
2. Mineral Wool Blanket: 2 inches thick and 4 lb/cu. ft. nominal density.

END OF SECTION

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for HVAC piping systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size.

1.4 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "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.

1.5 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials, Type II for sheet materials.

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. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

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. Aeroflex USA.
   b. Armacell LLC.
   c. K-Flex USA.

2. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.

3. Wet Flash Point: Below 0 deg F.

4. Color: Black.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents, unless otherwise approved by the engineer of record.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.

3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches o.c.

4. For below-ambient services, apply vapor-barrier mastic over staples.

5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.

6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using prefabricated fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is 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 prefabricated fitting insulationof same material and thickness as that 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 prefabricated fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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 prefabricated fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.

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 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.

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 conforms 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 that of adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 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 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.

3.6 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 that of 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 sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.

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 prefabricated valve covers manufactured of same material as that of pipe insulation when available.

2. When prefabricated 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 GLASS-FIBER AND MINERAL WOOL 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 jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with 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 prefabricated 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 glass-fiber or mineral-wool blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of 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 prefabricated sections of same material as that of straight segments of pipe insulation when available.

2. When prefabricated sections are not available, install fabricated 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 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "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.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Underground piping.

2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation is one of the following:

a. Flexible Elastomeric: 1 inch thick.

B. Chilled Water and Brine, 40 Deg F and below:

1. NPS 3 and Smaller: Insulation is one of the following:

a. Flexible Elastomeric: 1-1/2 inches thick.

2. NPS 4 to NPS 12: Insulation is one of the following:

a. Flexible Elastomeric: 1-1/2 inches thick.

3. NPS 14 and Larger: Insulation is one of the following:

a. Glass-Fiber, : 3 inches thick.
b. Mineral Wool, : 3 inches thick.

C. Chilled Water and Brine, Above 40 Deg F:

1. NPS 12 and Smaller: Insulation is one of the following:

a. Flexible Elastomeric: 1 inch thick.

2. NPS 14 and Larger: Insulation is one of the following:

a. Glass-Fiber : 3 inches thick.
b. Mineral Wool: : 3 inches thick.

D. Condenser-Water Supply and Return:

1. NPS 12 and Smaller: Insulation is one of the following:

a. Flexible Elastomeric: 1 inch thick.

2. NPS 14 and Larger: Insulation is one of the following:

a. Glass-Fiber, : 3 inches thick.

E. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 14 and Larger: Insulation is one of the following:

a. Glass-Fiber, : 3 inches thick.
b. Mineral Wool, : 3 inches thick.

F. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation is one of the following:

    a. Flexible Elastomeric: 1 inch thick.

G. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation is one of the following:

    a. Flexible Elastomeric: 2 inches thick.

H. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation is one of the following:

    a. Flexible Elastomeric: 1 inch thick.

I. Dual-Service Heating and Cooling, 40 to 200 Deg F:

1. NPS 12 and Smaller: Insulation is one of the following:

    a. Flexible Elastomeric: 2 inches thick.

2. NPS 14 and Larger: Insulation is one of the following:

    a. Mineral-Fiber, : 3 inches thick.

J. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation is one of the following:

    a. Flexible Elastomeric: 1 inch thick.
    b. Glass-Fiber, : 1 inch thick.
    c. Mineral Wool, : 1 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation is one of the following:

    a. Flexible Elastomeric: 3 inches thick.

B. Condenser-Water Supply and Return:

1. All Pipe Sizes: Insulation is one of the following:

    a. Flexible Elastomeric: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation is one of the following:

a. Flexible Elastomeric: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 2 inches thick.

E. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation is one of the following:

a. Flexible Elastomeric: 1 inch thick.

F. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation is one of the following:

a. Flexible Elastomeric: 2 inches thick.

3.12 OUTDOOR, UNDERGROUND, PIPING INSULATION SCHEDULE

A. Insulation for belowground piping is specified in Section 232113.13 "Underground Hydronic Piping" and Section 232213.13 "Underground Steam and Condensate Heating Piping."

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. .

D. Piping, Exposed:

1. None.
2. .

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. .

D. Piping, Exposed:

1. .

3.15 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1. Building Management System contractor shall provide controllers and adjustable space temperature sensors with LCD display and local unoccupied override from a single manufacturer.

B. System design shall follow BACnet/IP protocol and shall be web-based, accessible to those having proper passwords and authorization.

C. All power, communication, and data wiring, raceways, conduits, and accessories required for installation and operation of the Building Management System are the responsibility of the Building Management System Supplier and Installer.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. BMS: Building Management System (also referred to as BAS, Building Automation System).

C. I/O: Input/output.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.3 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

   a. Water Temperature: Plus or minus 1 deg F.
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
   f. Outside Air Temperature: Plus or minus 2 deg F.
   g. Dew Point Temperature: Plus or minus 3 deg F.
   h. Temperature Differential: Plus or minus 0.25 deg F.
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01-inch wg.
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
   o. Carbon Monoxide: Plus or minus 5 percent of reading.
   p. Carbon Dioxide: Plus or minus 50 ppm.
   q. Electrical: Plus or minus 5 percent of reading.

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

3. Wiring Diagrams: Power, signal, and control wiring.

4. Details of control panel faces, including controls, instruments, and labeling.

5. Written description of sequence of operation.

6. Schedule of dampers including size, leakage, and flow characteristics.

7. Schedule of valves including flow characteristics.

8. DDC System Hardware:

a. Wiring diagrams for control units with termination numbers.
b. Schematic diagrams and floor plans for field sensors and control hardware.
c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

10. Controlled Systems:

a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
c. Written description of sequence of operation including schematic diagram.
d. Points list.

1.5 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Qualification Data: For Installer and manufacturer.

C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device .

2. Interconnection wiring diagrams with identified and numbered system components and devices.

3. Keyboard illustrations and step-by-step procedures indexed for each operator function.

4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.

2. Program Software Backup: On a magnetic media or compact disc, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

5. Software license required by and installed for DDC workstations and control systems.

C. Equipment Control Drawings: Provide a laminated equipment control drawing with control sequence for each air handling unit located on or near the air handling unit as coordinated with the owner.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

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.

C. Comply with ASHRAE 135 for DDC system components.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.

2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

   a. Install updates only after receiving Owner's written authorization.

3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.

4. Warranty Period: One year from date of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer. BMS Supplier and Installer may request to factory mount any controls component they desire if arrangements are made with equipment vendors and factory mounting results in no additional cost to the Owner.

B. System Software: Update to latest version of software at Project completion.

1.10 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Install all space temperature sensors with center of device at 48" above finished floor unless noted otherwise.

B. Coordinate with equipment submitted to insure all controllers can be fully integrated into Building Management System.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

A. Manufacturers:

   1. Johnson Controls, Inc.; Controls Group. (No Substitutes)

B. Control system shall include the following:

1. Full operable graphics and integration of controls system into existing campus wide Johnson Controls, Inc., (JCI) controls system.

2.3 DDC EQUIPMENT

A. Internet Interface:

1. Application Software:

a. I/O capability from Internet.
b. System security for each operator via software password and access levels.
c. Automatic system diagnostics; monitor system and report failures.
d. Database creation and support.
e. Automatic and manual database save and restore.
f. Dynamic color graphic displays
g. Custom graphics generation and graphics library of HVAC equipment and symbols.
h. Alarm processing, messages, and reactions.
i. Trend logs retrievable in spreadsheets and database programs.
j. Alarm and event processing.
k. Automatic restart of field equipment on restoration of power.
l. Data collection, reports, and logs. Include standard reports for the following:

1) Current values of all objects.
2) Current alarm summary.
3) Disabled objects.
4) Alarm lockout objects.
5) Logs.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. 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.

2. 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, antishort cycling, PID control, DDC with fine tuning, and trend logging.
b. HVAC Control Programs: Optimal run time, supply-air reset, economizer cycle, and 7 day/24hour scheduling.
c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
d. Remote communications.

3. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

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.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. I/O Interface: Hardwired inputs and outputs may tie into system through 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.

5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).

6. 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.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.

2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

2.4 UNITARY CONTROLLERS

A. 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 the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72 -hour battery 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 automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135 .

4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.5 deg F at calibration point.

2. Wire: Twisted, shielded-pair cable.

3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..

4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..

5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.

6. Room Sensor Cover Construction: Manufacturer's standard with LCD display.

   a. Set-Point Adjustment: Exposed.
   b. Set-Point Indication: Exposed.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.

2. Wire: Twisted, shielded-pair cable.

3. 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..

4. Averaging Elements in Ducts: 24 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.

5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.

6. Room Sensor Cover Construction: Manufacturer's standard with LCD display.

   a. Set-Point Adjustment: Exposed.
   b. Set-Point Indication: Exposed.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

D. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 2 percent full range with linear output.

2. Room Sensor Range: 20 to 80 percent relative humidity.

3. Room Sensor Cover Construction: Manufacturer's standard with LCD display.

4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.

5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.

6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Duct Static-Pressure Range: 0- to 5-inch wg.

2. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

3. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.6 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. 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.

D. 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.

E. 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.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.7 Air FLOW MEASURING STATIONS

A. Duct Airflow Station: Provide thermal dispersion type, Ebtron or approved equal, where airflow measuring stations are required. Sensor accuracy shall be +-5% of reading throughout a full range of 0-2000 FPM..

2.8 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action. Electric actuators requiring 120 volt power to meet the specified operating characteristics shall be provided by the BMS supplier and installer as specified in Article: 3.3, ELECTRICAL AND COMMUNICATION WIRING AND CONNECTION INSTALLATION.

1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.

5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

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. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
   e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

3. Coupling: V-bolt and V-shaped, toothed cradle.

4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.

6. Power Requirements (Two-Position Spring Return): 24 -V ac unless indicated otherwise.

7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac 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 22 to plus 122 deg F.

10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

11. Run Time: 12 seconds open, 5 seconds closed.

2.9 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Application shall be such that pressure drop at design flow rate does not exceed 5 psig.

B. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

   a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:

   a. Two Position: Line size.
   b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

C. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals. All automatic butterfly control valves shall be factory tested for bubble tight shutoff at maximum pressure differential.

1. Body Style: Lug.

2. Disc Type: Nickel-plated ductile iron.

3. Sizing: 1-psig maximum pressure drop at design flow rate.

D. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg Foperating conditions.

2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.

3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.10 CONTROL DAMPERS

A. Dampers: AMCA-rated, opposed-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze 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.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.

3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units.

B. Request circuit assignments from Contractor as required to install Building Management System.

3.2 INSTALLATION

A. Install software in control units and front end. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor unless noted otherwise.

D. Install guards on thermostats in the following locations:

1. Where indicated.

E. Install automatic dampers according to Section 233300 "Air Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

H. Label all space temperature sensors with piece of equipment being controlled.

I. Install hydronic instrument wells, valves, and other accessories according to Section 232116 Hydronic Piping Specialties."

J. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."

3.3 ELECTRICAL AND COMMUNICATION WIRING AND CONNECTION INSTALLATION

A. It is the responsibility of the Building Management System Supplier and Installer to provide all necessary electrical power and communication wiring, conduit, raceways, and electrical components for a fully functional Building Management System.

B. Provide all required electrical power and communication wiring in compliance with Division 26 and 27.

C. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."

D. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

2. Install exposed cable in raceway.

3. Install concealed cable in raceway.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

8. All wiring materials shall be plenum rated.

F. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

G. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. 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. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.

3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

4. Test each point through its full operating range to verify that safety and operating control set points are as required.

5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

6. Test each system for compliance with sequence of operation.

7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.

2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check control valves. Verify that they are in correct direction.

5. Check DDC system as follows:

a. Verify that DDC controller power supply is from emergency power supply, if applicable.
b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
c. Verify that spare I/O capacity has been provided.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 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 without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training. “Instruction shall include explanation of how changing setpoints affect the systems.

END OF SECTION

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct digital control (DDC) system equipment and components for monitoring and controlling of HVAC, exclusive of instrumentation and control devices.

1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.

2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.

3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.

4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.

D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

J. E/P: Voltage to pneumatic.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

N. I/P: Current to pneumatic.

O. LAN: Local area network.

P. LNS: LonWorks Network Services.

Q. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.

2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.

3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.

4. LonWorks: Network technology developed by Echelon.

5. Node: Device that communicates using CTA-709.1-D protocol and that is connected to a CTA-709.1-D network.

6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.

7. Node ID: A unique 48-bit identifier assigned at factory to each CTA-709.1-D device. Sometimes called a "Neuron ID."

8. Program ID: An identifier (number) stored in a device (usually, EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.

9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark for configuration properties.

10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").

11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."

12. TP/FT-10: Free Topology Twisted Pair network defined by CTA-709.3 and is most common media type for a CTA-709.1-D control network.

13. TP/XF-1250: High-speed, 1.25 Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" and typically used only to connect multiple TP/FT-10 networks.

14. User-Defined Configuration Property Type (UCPT): Pronounced "u-keep-it." A Configuration Property format type that is defined by device manufacturer.

15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

R. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

S. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

T. Modbus TCP/IP: An open protocol for exchange of process data.

U. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

V. MTBF: Mean time between failures.

W. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.

Z. POT: Portable operator's terminal.

AA. RAM: Random access memory.

BB. RF: Radio frequency.

CC. Router: Device connecting two or more networks at network layer.

DD. Server: Computer used to maintain system configuration, historical and programming database.

EE. TCP/IP: Transport control protocol/Internet protocol.

FF. UPS: Uninterruptible power supply.

GG. USB: Universal Serial Bus.

HH. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

II. VAV: Variable air volume.

JJ. WLED: White light emitting diode.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

3. Product description with complete technical data, performance curves, and product specification sheets.

4. Installation, operation, and maintenance instructions including factors effecting performance.

5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.

   a. Workstations.
   b. Printers.
   c. Servers.
   d. Gateways.

e. Routers.
f. Protocol analyzers.
g. DDC controllers.
h. Enclosures.
i. Electrical power devices.
j. UPS units.
k. Accessories.
l. Instruments.
m. Control dampers and actuators.
n. Control valves and actuators.
o. .

6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.

7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

PART 2 - PRODUCTS

2.1 DDC SYSTEM 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. Johnson Controls, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. DDC system for monitoring and controlling of HVAC systems.

B. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

C. Delegated Design, Qualified Professional: Engage a qualified professional to design DDC system to satisfy requirements indicated.

1. System Performance Objectives:

a. DDC system manages HVAC systems.
b. DDC system operates HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system responds to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system operates while unattended by an operator and through operator interaction.

e. DDC system records trends and transactions of events and produces report information such as performance, energy, occupancies, and equipment operation.

D. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths complying with ASTM E84; 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 or less.

E. DDC System Speed:

1. Response Time of Connected I/O:

a. Update AI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
b. Update BI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
c. AO points connected to DDC system to begin to respond to controller output commands within two second(s). Global commands to also comply with this requirement.
d. BO point values connected to DDC system to respond to controller output commands within two second(s). Global commands to also comply with this requirement.

2. Display of Connected I/O:

a. Update and display analog point COV connected to DDC system at least every 10 seconds for use by operator.
b. Update and display binary point COV connected to DDC system at least every 10 seconds for use by operator.
c. Update and display alarms of analog and digital points connected to DDC system within 30 seconds of activation or change of state.
d. Update graphic display refresh within four seconds.
e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations to not exceed graphic refresh rate indicated.

F. DDC Data Access:

1. When logged into the system, operator able to also interact with any DDC controllers connected to DDC system as required for functional operation of DDC system.

2. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

G. Precision of I/O Reported Values: Values reported in database and displayed to have following precision:

1. Current:

    a. Milliamperes: Nearest 1/100th of a milliampere.
    b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.

2. Energy:

    a. Electric Power:

        1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
        2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
        3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.

    b. Fuel Oil (Usage): For gallons, nearest 1/10th of a gallon up to 100 gal.; nearest gallon for above 100 gal..
    c. Natural Gas (Usage): Nearest 1/10th of a unit (cubic feet, MCF, therm) up to 100 units; nearest unit for above 100 units.
    d. Thermal, Rate:

        1) Heating: For British thermal units per hour, nearest British thermal unit per hour up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For MBh, round to nearest MBh up to 1000 MBh; nearest 10 MBh between 1000 and 10,000 MBh; nearest 100 MBh above 10,000 MBh.
        2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.

    e. Thermal, Usage:

        1) Heating: For British thermal unit, nearest British thermal unit up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For MBtu, round to nearest MBtu up to 1000 MBtu; nearest 10 MBtu between 1000 and 10,000 MBtu; nearest 100 MBtu above 10,000 MBtu.
        2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.

3. Flow:

    a. Air: Nearest 1/10th of a cubic feet per minute through 100 cfm; nearest cubic feet per minute between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
    b. Fuel Oil: Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm.

c. Natural Gas:Nearest 1/10th of a cubic feet per hour through 100 cfh; nearest cubic feet per hour between 100 and 1000 cfh; nearest 10 cfh between 1000 and 10,000 cfh; nearest 100 cfh above 10,000 cfh.
d. Water: Nearest 1/10th of a gallon per minute through 100 gpm; nearest gallon per minute between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
e. Steam: Nearest 1/10th of a pound per hour through 100 lb/h; nearest pound per hour between 100 and 1000 lb/h; nearest 10 lb/h above 1000 lb/h.

4. Gas:

a. Carbon Dioxide (ppm): Nearest ppm.
b. Carbon Monoxide (ppm): Nearest ppm.
c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
d. Refrigerant (ppm): Nearest ppm.
e. Volatile Organic Compounds (ppm): Nearest ppm

5. Moisture (Relative Humidity):

a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.

7. Speed:

a. Rotation (rpm): Nearest 1 rpm.
b. Velocity: Nearest 1/10th of feet per minute through 100 fpm; nearest feet per minute between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.

8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.

9. Pressure:

a. Air, Ducts and Equipment: Nearest 1/10th of an inch water closet.
b. Space: Nearest 1/100th of an inch water closet.
c. Steam: Nearest 1/10th of pounds per square inch gauge through 100 psig; nearest pounds per square inch gauge above 100 psig.
d. Water: Nearest 1/10 of a pound per square inch gauge through 100 psig; nearest pound per square inch gauge above 100 psig.

10. Temperature:

a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
b. Outdoor: Nearest degree.
c. Space: Nearest 1/10th of a degree.
d. Chilled Water: Nearest 1/10th of a degree.
e. Condenser Water: Nearest 1/10th of a degree.
f. Heating Hot Water: Nearest degree.
g. Heat Recovery Runaround: Nearest 1/10th of a degree.
h. Steam: Nearest degree.

11. Vibration: Nearest 1/10th of an inch per second.
12. Voltage: Nearest 1/10 V up to 100 V; nearest volt above 100 V.

H. Control Stability: Control variables indicated within the following limits:

1. Flow:

   a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
   b. Air, Terminal Units: Within 5 percent of design flow rate.
   c. Water: Within 5 percent of design flow rate.

2. Moisture (Relative Humidity):

   a. Air: Within 5 percent RH.
   b. Space: Within 5 percent RH.
   c. Outdoor: Within 5 percent RH.

3. Level: Within 5 percent of reading.

4. Pressure:

   a. Air, Ducts and Equipment: 1 percent of instrument range.
   b. Space: Within 1 percent of instrument range.
   c. Water: Within 1 percent of instrument range.
   d. Steam: Within 1 percent of instrument range.

5. Temperature, Dew Point:

   a. Air: Within 1 deg F.
   b. Space: Within 1 deg F.

6. Temperature, Dry Bulb:

   a. Air: Within 0.5 deg F.
   b. Space: Within 0.5 deg F.
   c. Chilled Water: Within 0.5 deg F.
   d. Condenser Water: Within 0.5 deg F.
   e. Heating Hot Water: Within 0.5 deg F.

7. Temperature, Wet Bulb:

   a. Air: Within 0.5 deg F.
   b. Space: Within 0.5 deg F.

I. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.

a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.

2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: Type 3.
b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated with Filtered Ventilation: Type 2.
d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
e. Indoors, Heated and Air-Conditioned: Type 1.
f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: Type 4.
2) Air-Moving Equipment Rooms: Type 2.

g. Localized Areas Exposed to Washdown: Type 4.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
j. Hazardous Locations: Explosion-proof rating for condition.

J. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure is internally insulated, electrically heated, cooled, and ventilated as required by instrument and application.

2. Protect instruments, actuators, and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House instruments and actuators not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location is to dictate the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: Type 3.
b. Outdoors, Unprotected: Type 4.
c. Indoors, Heated with Filtered Ventilation: Type 2.
d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
e. Indoors, Heated and Air-conditioned: Type 1.
f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: Type 4.
2) Air-Moving Equipment Rooms: Type 2.

g. Localized Areas Exposed to Washdown: Type 4.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
j. Hazardous Locations: Explosion-proof rating for condition.

K. DDC System Reliability:

1. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment being controlled, operational, and under automatic control.

2. See Drawings for critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated.

L. Electric Power Quality:

1. Power-Line Surges:

a. Protect susceptible DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.1 and IEEE C62.41.2.
b. Do not use fuses for surge protection.
c. Test protection in the normal mode and in the common mode, using the following two waveforms:

1) 10-by-1000-microsecond waveform with a peak voltage of 1500 V and a peak current of 60 A.
2) 8-by-20-microssecond waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

a. Protect susceptible DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner are as follows:

1) At 85 percent load, output voltage to not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
2) During load changes from zero to full load, output voltage to not deviate by more than 3 percent of nominal.
3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
4) Total harmonic distortion to not exceed 3 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products to not fail due to ground fault condition.

M. Backup Power Source:

1. Serve DDC system products that control HVAC systems and equipment served by a backup power source also from a backup power source.

N. UPS:

1. DDC system products powered by UPS units are to include the following:

a. Servers.
b. Gateways.
c. DDC controllers, except application-specific controllers.
d. Desktop workstations.

O. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems are to automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system has communication interface with equipment having integral controls and having communication interface for remote monitoring or control.

2. Equipment to Be Connected:

a. Domestic water booster pumps specified in Section 221123.13 "Domestic-Water Packaged Booster Pumps."
b. Sewage pump stations specified in Section 221343 "Facility Packaged Sewage Pumping Stations."
c. Sump pumps specified in Section 221429 "Sump Pumps."
d. Air-compressors and air driers specified in Section 221519 "General-Service Packaged Air Compressors and Receivers" and Section 226119 "Compressed-Air Equipment for Laboratory and Healthcare Facilities."
e. Domestic water softeners specified in Section 223100 "Domestic Water Softeners."
f. Domestic water heaters specified in Section 223300 "Electric, Domestic-Water Heaters" and Section 223400 "Fuel-Fired, Domestic-Water Heaters."
g. Vacuum equipment specified in Section 226219 "Vacuum Equipment for Laboratory and Healthcare Facilities."
h. Processed water equipment specified in Section 226719 "Processed Water Equipment for Laboratory and Healthcare Facilities."
i. Air curtains specified in Section 233433.16 "Industrial Air Curtains."
j. Air-terminal units specified in Section 233600 "Air Terminal Units."
k. Kitchen hoods specified in Section 233813 "Commercial-Kitchen Hoods."
l. Boilers specified in Section 235213 "Electric Boilers."
m. Boilers specified in Section 235216 "Condensing Boilers."
n. Boilers specified in Section 235223 "Cast-Iron Boilers."
o. Boilers specified in Section 235233 "Water-Tube Boilers."
p. Boilers specified in Section 235239 "Fire-Tube Boilers."
q. Feedwater equipment specified in Section 235313 "Boiler Feedwater Pumps."
r. Deaerators specified in Section 235316 "Deaerators."
s. Chillers specified in Section 236413.13 "Direct-Fired Absorption Water Chillers."
t. Chillers specified in Section 236413.16 "Indirect-Fired Absorption Water Chillers."
u. Chillers specified in Section 236416 "Centrifugal Water Chillers."
v. Chillers specified in Section 236423.13 "Air-Cooled, Scroll Water Chillers."
w. Chillers specified in Section 236423.16 "Water-Cooled, Scroll Water Chillers."
x. Chillers specified in Section 236426.13 "Air-Cooled, Rotary-Screw Water Chillers."
y. Chillers specified in Section 236426.16 "Water-Cooled, Rotary-Screw Water Chillers."
z. Cooling towers specified in Section 236513.13 "Open-Circuit, Forced-Draft Cooling Towers."
aa. Cooling towers specified in Section 236513.16 "Closed-Circuit, Forced-Draft Cooling Towers."
bb. Cooling towers specified in Section 236514.13 "Open-Circuit, Induced-Draft, Counterflow Cooling Towers."

cc. Cooling towers specified in Section 236514.14 "Open-Circuit, Induced-Draft, Crossflow Cooling Towers."
dd. Cooling towers specified in Section 236514.16 "Closed-Circuit, Induced-Draft, Counterflow Cooling Towers."
ee. Cooling towers specified in Section 236514.17 "Closed-Circuit, Induced-Draft, Combined-Flow Cooling Towers."
ff. Heat wheels specified in Section 237223.13 "Packaged Indoor Heat Wheel Energy Recovery Units" and Section 237223.23 "Packaged, Outdoor, Heat Wheel Energy Recovery Units."
gg. Heat exchangers specified in Section 237223.19 "Packaged Indoor Fixed Plate Energy Recovery Units" and Section 237223.29 "Packaged, Outdoor, Fixed Plate Energy Recovery Units"
hh. Air-handling units specified in Section 237313.13 "Indoor, Basic Air-Handling Units."
ii. Air-handling units specified in Section 237313.16 "Indoor, Semi-Custom Air-Handling Units."
jj. Air-handling units specified in Section 237313.19 "Indoor, Custom Air-Handling Units."
kk. Heating and ventilating units specified in Section 237333.16 "Indoor, Indirect, Gas-Fired Heating and Ventilating Units."
ll. Heating and ventilating units specified in Section 237339 "Indoor, Direct-Fired Heating and Ventilating Units."
mm. Air-handling units specified in Section 237343.16 "Outdoor, Semi-Custom Air-Handling Units."
nn. Air-handling units specified in Section 237343.19 "Outdoor, Custom Air-Handling Units."
oo. Roof-top units specified in Section 237416.11 "Packaged, Small-Capacity, Rooftop Air-Conditioning Units."
pp. Roof-top units specified in Section 237416.13 "Packaged, Large-Capacity, Rooftop Air-Conditioning Units."
qq. Make-up air units specified in Section 237423.13 "Packaged, Direct-Fired, Outdoor, Heating-Only Makeup-Air Units."
rr. Make-up air units specified in Section 237423.16 "Packaged, Indirect-Fired, Outdoor, Heating-Only Makeup-Air Units."
ss. Dedicated outdoor-air units specified in Section 237433 "Dedicated Outdoor-Air Units."
tt. Packaged terminal air-conditioners specified in Section 238113.11 "Packaged Terminal Air-Conditioners, Through-Wall Units."
uu. Packaged terminal air-conditioners specified in Section 238113.12 "Packaged Terminal Air-Conditioners, Freestanding Units."
vv. Packaged terminal air-conditioners specified in Section 238113.13 "Packaged Terminal Air-Conditioners, Outdoor, Wall-Mounted Units."
ww. Computer-room air-conditioning units specified in Section 238123.11 "Small Capacity (6 Tons and Smaller), Computer-Room Air-Conditioners, Floor-Mounted Units."
xx. Computer-room air-conditioning units specified in Section 238123.12 "Large Capacity (7 Tons and Larger), Computer-Room Air-Conditioners, Floor-Mounted Units."
yy. Computer-room air-conditioning units specified in Section 238123.13 "Computer-Room Air Conditioners, Ceiling-Mounted Units."

zz. Computer-room air-conditioning units specified in Section 238123.14 "Computer-Room Air Conditioners, Console Units."
aaa. Computer-room, rack-mounted cooling equipment specified in Section 238123.18 "Computer-Room, Rack-Cooling Equipment."
bbb. Variable refrigerant flow units specified in Section 238129 "Variable-Refrigerant-Flow HVAC Systems."
ccc. Fan-coil units specified in Section 238219 "Fan Coil Units."
ddd. Unit ventilators specified in Section 238223 "Unit Ventilators."
eee. Wetted-element humidifiers specified in Section 238413.16 "Wetted-Element Humidifiers."
fff. Atomizing humidifiers specified in Section 238413.19 "Atomizing Humidifiers."
ggg. Direct-steam-injection humidifiers specified in Section 238413.23 "Direct-Steam-Injection Humidifiers."
hhh. Self-contained steam humidifiers specified in Section 238413.29 "Self-Contained Steam Humidifiers."
iii. Heat exchanger humidifiers specified in Section 238413.36 "Heat Exchanger Humidifiers."
jjj. Dehumidification units specified in Section 238416.13 "Outdoor, Mechanical Dehumidification Units" and in Section 238416.16 "Indoor, Mechanical Dehumidification Units."
kkk. Switchboards specified in Section 262300 "Low-Voltage Switchgear."
lll. Motor-control centers specified in Section 262419 "Motor-Control Centers."
mmm. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Motor Controllers."
nnn. Diesel emergency engine generators specified in Section 263213.13 "Diesel-Engine-Driven Generator Sets."
ooo. Gaseous emergency engine generators specified in Section 263213.16 "Gas-Engine-Driven Generator Sets."
ppp. Bi-fuel emergency engine generators specified in Section 263213.19 "Bi-Fuel-Engine-Driven Generator Sets."
qqq. UPS specified in Section 263353 "Static Uninterruptible Power Supply."
rrr. Refrigerant monitoring specified in Section 284400 "Refrigerant Detection and Alarm."

B. Communication Interface to Other Building Systems:

1. DDC system communicates with systems having communication interface.
2. Systems to Be Connected:

a. Elevators specified in Section 142100 "Electric Traction Elevators."
b. Elevators specified in Section 142113 "Electric Traction Freight Elevators."
c. Elevators specified in Section 142400 "Hydraulic Elevators."
d. Elevators specified in Section 142413 "Hydraulic Freight Elevators."
e. Escalators specified in Section 143100 "Escalators."
f. Automated water treatment systems specified in Section 232500 "HVAC Water Treatment."
g. Automated water treatment systems specified in Section 232516 "Water Treatment for Open-Loop Hydronic Systems."
h. Automated water treatment systems specified in Section 232519 "Water Treatment for Steam System Feedwater."
i. Power monitoring specified in Section 260913 "Electrical Power Monitoring."

j. Lighting controls specified in Section 260936 "Modular Dimming Controls."
k. Lighting controls specified in Section 260943.16 "Addressable Luminaire Lighting Controls."
l. Lighting controls specified in Section 260943.23 "Relay-Based Lighting Controls."
m. Fire-alarm system specified in Section 284621.11 "Addressable Fire-Alarm Systems."
n. Fire-alarm system specified in Section 284621.13 "Conventional Fire-Alarm Systems."
o. Access controls specified in Section 281300 "Access Control System Software and Database Management."
p. Intrusion detection specified in Section 283100 "Intrusion Detection."
q. Perimeter security specified in Section 283121 "Area and Perimeter Intrusion Detection."

3.3 PREINSTALLATION INTEGRATION TESTING

A. Perform the following pretesting of other systems and equipment integration with DDC system before field installation:

1. Test all communications in a controlled environment to ensure connectivity.

2. Load software and demonstrate functional compliance with each control sequence of operation indicated.

3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:

a. HVAC equipment controlled through DDC system, such as boilers, chillers, pumps, and air-handling units.
b. Equipment faults and system recovery with fault annunciation.
c. Analog and Boolean value alarming and annunciation.

4. Develop a method for testing interfaces before deployment.

5. Submit documentation supporting compliance upon request.

3.4 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. Interface DDC systems with existing systems to achieve integration indicated.
2. Monitoring and Control of DDC System by Existing Control System:

a. Satisfy DDC system performance requirements when monitoring and controlling DDC system by existing control system.
b. Operator of existing system to upload, download, monitor, trend, control, and program every I/O point in DDC system from existing control system using existing control system software and operator workstations.

c. Make interface so operator of existing system is not required to learn new software for remote monitoring and control from existing control system.
d. Make interface of DDC system into existing control system transparent to operators of existing control system and allow operators to program, monitor, and control DDC system from any operator workstation connected to existing control system.

3. Integration of Existing Control System into DDC System:

a. Satisfy existing control system performance requirements when monitoring and controlling existing control system through DDC system.
b. Operator to upload, download, monitor, alarm, report, trend, control, and program every I/O point in existing system from DDC system using operator workstations and software provided. Combined systems to share one database.
c. Make interface of existing control system I/O points into DDC system transparent to operators. Make all operational capabilities identical regardless of whether I/O already exists, or I/O is being installed.

B. Integration with Existing Enterprise System:

1. Interface DDC system with an existing enterprise system to adhere to Owner standards already in-place and to achieve integration.

2. Owner's control system integrator to provide the following services:

a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

3. Engage Owner's control system integrator to provide the following services:

a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

4. Attend meetings with control system integrator to integrate DDC system.

3.5 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control dampers, which are specified in Section 230923.12 "Control Dampers."

2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."

3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control valves, which are specified in Section 230923.11 "Control Valves."

2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."

3. Pipe-mounted sensors, switches, and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments."

4. Tank-mounted sensors, switches, and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."

5. Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."

6. Pipe- and tank-mounted thermowells. Liquid thermowells are specified in Section 230923.27 "Temperature Instruments."

3.6 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

D. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."

F. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

G. Welding Requirements:

1. Restrict welding and burning to supports and bracing.

2. No equipment is cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.

3. Welding, where approved, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with applicable welding codes.

4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

H. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

I. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

J. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments including, but not limited to, the following:

a. Laboratory exhaust-air streams.
b. Process exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

3. Where instruments are located in a corrosive airstream and are not already corrosive resistant from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.7 INSTALLATION OF WORKSTATIONS

A. Color Graphics Application:

1. Use system schematics indicated on Drawings as starting point to create graphics.

2. Develop Project-specific library of symbols for representing system equipment and products.

3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.

4. Seek Owner input in graphics development once using graphics software.

5. Refine graphics as necessary for Owner acceptance.

6. On receiving Owner acceptance, print a PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

B. Retractable, Wall-Mounted Cabinet for Portable Operator's Workstation Installation:

1. Install retractable, wall-mounted portable operator's workstation cabinet(s) at location(s) indicated on Drawings.

2. Install retractable, wall-mounted portable operator's workstation cabinet(s) at following location(s) and at additional locations indicated on Drawings:

a. Each mechanical room.
b. Chiller room.
c. Boiler room.

3. Connect each cabinet to 120 V, single-phase, 60 Hz field power source and install single gang electrical box with NEMA WD 6, Type 20R duplex receptacle and metal cover plate in cabinet. Comply with requirements in Section 262726 "Wiring Devices."

4. Connect each cabinet to Ethernet network and install an Ethernet network port for connection to portable operator workstation Ethernet cable. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

3.8 INSTALLATION OF GATEWAYS

A. Install gateways if required for DDC system communication interface requirements indicated.

1. Install gateway(s) required to suit indicated requirements.

B. Test gateways to verify that communication interface functions properly.

3.9 INSTALLATION OF ROUTERS

A. Install routers if required for DDC system communication interface requirements indicated.

1. Install router(s) required to suit indicated requirements.

B. Test routers to verify that communication interface functions properly.

3.10 INSTALLATION OF CONTROLLERS

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply.

C. Install controllers with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

3.11 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.12 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

   a. Assign and document a MAC address unique to its network for every network device.
   b. Ethernet Networks: Document MAC address assigned at its creation.
   c. MS/TP Networks: Assign from 00 to 64.

2. Network Numbering:

   a. Assign unique numbers to each new network.
   b. Provide ability for changing network number through device switches or operator interface.
   c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

   a. Assign unique device object identifier property numbers or device instances for each device network.

b. Provide for future modification of device instance number by device switches or operator interface.
c. LAN is to support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

a. Device object name property field to support 32 minimum printable characters.
b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

1) Example 1: Device object name for device controlling heating water boiler plant at Building 1000 would be "Heating Water System Bldg. 1000."
2) Example 2: Device object name for VAV terminal unit controller could be "VAV Unit 102."

5. Object Name Property Text for Other Than Device Objects:

a. Object name property field is to support 32 minimum printable characters.
b. Assign object name properties with plain-English names descriptive of application.

1) Example 1: "Zone 1 Temperature."
2) Example 2 "Fan Start and Stop."

6. Object Identifier Property Number for Other Than Device Objects:

a. Assign object identifier property numbers according to Drawings indicated.
b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented, and be unique for like object types within device.

3.13 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic control dampers, verify that pressure gauges are provided in each air line connected to the damper actuator and positioner.

2. Verify that control dampers are installed correctly for flow direction.

3. Verify that proper blade alignment, either parallel or opposed, has been provided.

4. Verify that damper frame attachment is properly secured and sealed.

5. Verify that damper actuator and linkage attachment are secure.

6. Verify that actuator wiring is complete, enclosed, and connected to correct power source.

7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic control valves, verify that pressure gauges are provided in each air line connected to the valve actuator and positioner.

2. Verify that control valves are installed correctly for flow direction.

3. Verify that valve body attachment is properly secured and sealed.

4. Verify that valve actuator and linkage attachment are secure.

5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.

6. Verify that valve ball, disc, or plug travel is unobstructed.

7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.

2. Verify that attachment is properly secured and sealed.

3. Verify that conduit connections are properly secured and sealed.

4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.

5. Inspect instrument tag against approved submittal.

6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.

7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.

8. For temperature instruments, verify the following:

a. Sensing element type and proper material.

b. Length and insertion.

3.14 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.

F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.

G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.

H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.

2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.

2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.

2. Stroke pneumatic control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

3. Check and document open and close cycle times for applications with cycle time less than 30 seconds.

4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.

2. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

3. Check and document open and close cycle times for applications with cycle time less than 30 seconds.

4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

O. Switches: Calibrate switches to make or break contact at set points indicated.

P. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.

2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.15 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.

2. Verify that protection from power surges is installed and functioning.

3. Verify that ground fault protection is installed.

4. If applicable, verify if connected to UPS unit.

5. If applicable, verify if connected to backup power source.

6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.16 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.

2. Test every I/O point throughout its full operating range.

3. Test every control loop to verify that operation is stable and accurate.

4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.

5. Test and adjust every control loop for proper operation according to sequence of operation.

6. Test software and hardware interlocks for proper operation. Correct deficiencies.

7. Operate each analog point at the following:

   a. Upper quarter of range.
   b. Lower quarter of range.
   c. At midpoint of range.

8. Exercise each binary point.

9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller, and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller, and at field instrument must match.

10. Prepare and submit report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.17 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After review of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed Pretest Checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.

2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.

3. HVAC equipment motors operate below full-load amperage ratings.

4. Required DDC system components, wiring, and accessories are installed.

5. Installed DDC system architecture matches approved Drawings.

6. Control electric power circuits operate at proper voltage and are free from faults.

7. Required surge protection is installed.

8. DDC system network communications function properly, including uploading and downloading programming changes.

9. Using BACnet protocol analyzer, verify that communications are error free.

10. Each controller's programming is backed up.

11. Equipment, products, tubing, wiring cable, and conduits are properly labeled.

12. All I/O points are programmed into controllers.

13. Testing, adjusting, and balancing work affecting controls is complete.

14. Dampers and actuators zero and span adjustments are set properly.

15. Each control damper and actuator goes to failed position on loss of power and loss of signal.

16. Valves and actuators zero and span adjustments are set properly.

17. Each control valve and actuator goes to failed position on loss of power and loss of signal.

18. Meter, sensor, and transmitter readings are accurate and calibrated.

19. Control loops are tuned for smooth and stable operation.

20. View trend data where applicable.

21. Each controller works properly in standalone mode.

22. Safety controls and devices function properly.

23. Interfaces with fire-alarm system function properly.

24. Electrical interlocks function properly.

25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.

26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit validation Test Plan including test procedures for performance validation tests.

2. Address all specified functions of DDC system and sequences of operation in Test Plan.

3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.

4. Explain method for simulating necessary conditions of operation used to demonstrate performance.

5. Include Test Checklist to be used to check and initial that each test has been successfully completed.

6. Submit Test Plan documentation 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.

   a. Verify analog I/O points at operating value.
   b. Make adjustments to out-of-tolerance I/O points.

      1) Identify I/O points for future reference.
      2) Simulate abnormal conditions to demonstrate proper function of safety devices.
      3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.

3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.

4. 24 hours after initial validation test, do as follows:

    a. Re-check I/O points that required corrections during initial test.
    b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. 24 Hours after second validation test, do as follows:

    a. Re-check I/O points that required corrections during second test.
    b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.

7. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.

    a. Heavy load to be occurrence of 50 percent of total connected binary COV, one-half of which represents "alarm" condition, and 50 percent of total connected analog COV, one-half of which represents "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.

3. Measure with timer having at least 0.1-second resolution and 0.01 percent accuracy.

4. Purpose of test is to demonstrate DDC system, as follows:

    a. Reaction to COV and alarm conditions during HLC.
    b. Ability to update DDC system database during HLC.

5. Passing test is contingent on the following:

    a. Alarm reporting at printer beginning no more than two seconds after initiation (time zero) of HLC.
    b. All alarms, both binary and analog, are reported and printed; none are lost.
    c. Compliance with response times specified.

6. Prepare and submit report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.

2. To pass, none of DDC system networks are to use more than 70 percent of available bandwidth under normal and HLC operation.

3.18 VERIFICATION OF DDC SYSTEM WIRELESS NETWORK

A. DDC system Installer is to design wireless DDC system networks to comply with performance requirements indicated.

B. Verify wireless network performance through field testing and document results in a field test report.

C. Testing and verification of all wireless devices to include, but not be limited to, the following:

1. Speed.

2. Online status.

3. Signal strength.

3.19 FINAL REVIEW

A. Submit written request to Architect Construction Manager when DDC system is ready for final review. State the following:

1. DDC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.

2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.

3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.

4. DDC system is complete and ready for final review.

B. Upon receipt of written request for final review, Construction Manager to start review within reasonable period and upon completion issue field report(s) documenting observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Compensation for Subsequent Reviews: Should more than two reviews be required, DDC system manufacturer and Installer to compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by DDC system manufacturer and Installer before review.

E. Prepare and submit closeout submittals when no deficiencies are reported.

F. Part of DDC system final review shall to include demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.

2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.

3. Demonstration to include, but not be limited to, the following:

a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points to be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
d. Operation of randomly selected dampers and valves in normal-on, normal-off, and failed positions.
e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
f. Trends, summaries, logs, and reports set up for Project.
g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
h. Software's ability to communicate with controllers, operator workstations, and uploading and downloading of control programs.
i. Software's ability to edit control programs offline.
j. Data entry to show Project-specific customizing capability including parameter changes.
k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
l. Execution of digital and analog commands in graphic mode.
m. Spreadsheet and curve plot software and its integration with database.
n. Online user guide and help functions.
o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
p. System speed of response compared to requirements indicated.
q. For Each Network Controller:

1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
4) Electric Power: Ability to disconnect any controller safely from its power source.
5) Wiring Labels: Match control drawings.
6) Network Communication: Ability to locate controller's location on network and communication architecture matches Shop Drawings.
7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

r. For Each Operator Workstation:

1) I/O points lists agree with naming conventions.
2) Graphics are complete.
3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.

10) Device and Network Management:

a) Display of network device status.
b) Display of BACnet object information.
c) Silencing devices transmitting erroneous data.
d) Time synchronization.
e) Remote device re-initialization.
f) Backup and restore network device programming and master database(s).
g) Configuration management of routers.

3.20 EXTENDED OPERATION TEST

A. Operate DDC system for operating period of 28 consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.

B. Provide operator familiar with DDC system installed to man an operator workstation while on-site during eight hours of each normal business day occurring during operating period.

C. During operating period, DDC system to demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.

1. Correct defects of hardware and software when they occur.

D. Definition of Failures and Downtime during Operating Period:

1. Failed I/O point constituting downtime is I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.

2. Downtime is when any I/O point in DDC system is unable to fulfill its required function.

3. Calculate downtime as elapsed time between detected point failure as confirmed by operator, and time point is restored to service.

4. Maximum time interval allowed between DDC system detection of failure occurrence and operator confirmation is to be 0.5 hours.

5. Log downtime in hours to nearest 0.1 hour.

6. Power outages do not count as downtime, but do suspend test hours unless systems are provided with UPS and served through a backup power source.

7. Hardware or software failures caused by power outages do count as downtime.

E. During operating period, log downtime and operational problems are encountered.

1. Identify source of problem.

2. Provide written description of corrective action taken.

3. Record duration of downtime.

4. Maintain log showing the following:

   a. Time of occurrence.
   b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
   c. Downtime for each failed I/O point.
   d. Running total of downtime and total time of I/O point after each problem has been restored.

5. Make log available to Owner for review at any time.

F. For DDC system to pass extended operation test, total downtime is limited to 1 percent of total point-hours during operating period.

1. If DDC system testing results fail to comply with minimum requirements of passing at end of operating period indicated, extend operating period one consecutive day at a time until DDC system passes requirement.

G. Base evaluation of DDC system passing test on the following calculation:

1. Count downtime on point-hour basis where total number of DDC system point-hours is equal to total number of I/O points in DDC system multiplied by total number of hours during operating period.

2. One point-hour of downtime is one I/O point down for one hour. For example, three I/O points down for five hours is total of 15 point-hours of downtime. Four points down for one-half hour is two point-hours of downtime.
3. Example Calculation: Maximum allowable downtime for 30-day test for DDC system with 1000 total I/O points (combined analog and binary) and passing score of 1 percent downtime is computed by 30 days x 24 h/day x 1000 points x 1 percent equals 7200 point-hours of maximum allowable downtime.

H. Prepare test and inspection reports.

3.21 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.22 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes 12 months' full maintenance by DDC system manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration, and adjusting as required for proper operation. Use only manufacturer's authorized replacement parts and supplies.

3.23 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, verify that service agreement includes software support for two year(s).

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two year(s) from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

1. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

END OF SECTION

SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball-style control valves.

2. Electric and electronic control valve actuators.

1.2 DEFINITIONS

A. Cv: Valve coefficient.

B. DDC: Direct digital control.

C. EPT: Ethylene-propylene terpolymer rubber.

D. HNBR: Hydrogenated nitrile butadiene rubber.

E. NBR: Nitrile butadiene rubber.

F. PEEK: Polyether Ether Ketone rubber.

G. PTFE: Polytetrafluoroethylene.

H. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

I. RTFE: Glass-fiber-reinforced PTFE.

J. TFM: A chemically modified PTFE.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

3. Product description with complete technical data, performance curves, and product specification sheets.

4. Installation, operation, and maintenance instructions, including factors affecting performance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

D. Code Compliance: Comply with governing energy code.

E. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

F. Backup Power Source: Serve control valve actuators from a backup power source where associated with systems and equipment served by a backup power source.

G. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

H. Sizing Criteria: Unless otherwise indicated, select control valve size using the following:

1. ISA Standards:

   a. Control Valve Sizes and Flow Coefficients: ISA 75.01.01.
   b. Control Valve Characteristics and Rangeability: ISA 75.11.01.

2. Correction Factors: Consider viscosity, flashing, and cavitation corrections when selecting control valves.

3. Ball-Style Control Valves: Select valve size with design Cv at design flow between 65 and 75 degrees of valve full open position and minimum Cv between 15 and 25 percent of open position.

4. Butterfly-Style Control Valves: Select valve size with design Cv at design flow between 65 and 75 degrees of valve full open position and minimum Cv between 15 and 25 percent of open position.

5. Retain "Globe-Style Control Valves" Subparagraph below for globe control valves.

6. Globe-Style Control Valves: Select valve size to pass the design Cv at design flow with not more than 95 percent of stem travel.

7. Modulating Control Valves in Hydronic Systems:

   a. Select modulating control valve sizes at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow.
   b. Calculate control valve minimum Cv at 10 percent of control valve design flow, with a coincident pressure differential equal to the system design pump head.

8. Two-Position Valves: Select two-position control valves for full pipeline size.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Characterized Disk and Threaded Ends, Two Way:

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. Belimo Aircontrols (USA), Inc.
   b. Honeywell Building Solutions; Honeywell International, Inc.
   c. Johnson Controls, Inc.
   d. Siemens Industry, Inc., Building Technologies Division.
   e. Hydronic Components Inc.

2. Source Limitations: Obtain two-way ball valves, with characterized disk and threaded ends, from single manufacturer.

B. Ball Valves with Characterized Disk and Threaded Ends, Three Way:

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. Belimo Aircontrols (USA), Inc.
   b. Honeywell Building Solutions; Honeywell International, Inc.
   c. Johnson Controls, Inc.
   d. Siemens Industry, Inc., Building Technologies Division.

2. Source Limitations: Obtain three-way ball valves, with characterized disk and threaded ends, from single manufacturer.

C. Ball Valves with Full Ball and Characterized V-Notch, Two Way:

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. Flo-Tite, Inc.
   b. Flow-Tek, Inc.

c. Valve Solutions, Inc.

2. Source Limitations: Obtain two-way ball valves, with full ball and characterized v-notch, from single manufacturer.

3. Standards: ASME B16.34, MSS SP-72.
4. Features:

a. Full port.
b. Replaceable ball, seat, shaft bushings, and packing.
c. Pressure equalized between body cavity and the line flow.
d. Universal mounting pad complying with ISO 5211 for actuator mounting.

5. Label each valve with following:

a. Manufacturer's name, model number, and serial number.
b. Body size.
c. Flow directional arrow.

2.3 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

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. Belimo Aircontrols (USA), Inc.
2. Bray International, Inc.
3. Fisher Valves & Instruments; Emerson Process Management.
4. Flo-Tite, Inc.
5. Flowserve Corporation.
6. Honeywell International Inc.
7. Johnson Controls, Inc.
8. Jordan Valve; Richards Industries Company.
9. Keystone; Emerson Electric Co., Automation Solutions.
10. Max-Seal, Inc.
11. Milwaukee Valve Company.
12. NIBCO INC.
13. Siemens Industry, Inc., Building Technologies Division.
14. Spence; Emerson Process Management.
15. Spirax Sarco Limited.
16. Valve Solutions, Inc.

B. Furnish control valves with factory-installed actuators from control valve manufacturer. Actuators manufactured by listed control valve manufacturers are acceptable subject to compliance with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support control valves and actuators, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic event, wind, or others forces common to the application.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Seal penetrations made in fire-rated and acoustically rated assemblies.

F. Fastening Hardware:

1. Wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.

2. Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.

3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

4. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 CONTROL VALVES

A. Install pipe reducers for control valves smaller than line size. Position reducers as close to control valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Drain Valves:

1. Install drain valves in piping upstream and downstream of each control valve larger than NPS 2.

2. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold.

D. Test Plugs: Install pressure temperature test plugs in piping upstream and downstream of each control valve.

E. Three-Valve Bypass Manifold: Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing isolation valves in inlet and discharge piping of control valve and a manual throttling valve in bypass pipe.

F. Valve Orientation:

1. Where possible, install ball valves that are installed in horizontal piping, with stems upright and not more than 15 degrees off of vertical, not inverted.

2. Install valves in a position to allow full stem movement.

3. Retain subparagraph below for butterfly valves.

4. Where possible, install butterfly valves that are installed in horizontal piping, with stems in horizontal position and with low point of disc opening with direction of flow.

G. Clearance:

1. Locate valves for easy access, and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.

2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.

2. Align threads at point of assembly.

3. Apply thread compound to external pipe threads, except where dry seal threading is specified.

4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:

1. Align flange surfaces parallel.

2. Assemble joints by sequencing bolt-tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Use same designation at each end for each piece of wire, cable, and tubing for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with valve identification on valve and on face of ceiling directly below valves concealed above ceilings. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 CONTROL CONNECTIONS

A. Pneumatic Control Connections: Connect pneumatic control valve actuators and accessories to pneumatic main and signal air. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

B. Install control signal wiring to field-mounted control devices.

C. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.

2. Check valves for proper location and accessibility.

3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

4. For pneumatic products, verify air supply for each product is properly installed.

5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.

6. Verify that control valves are installed correctly for flow direction.

7. Verify that valve body attachment is properly secured and sealed.

8. Verify that valve actuator and linkage attachment are secure.

9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.

10. Verify that valve ball, disc, and plug travel are unobstructed.

11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 15 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Joining materials.
4. Manual gas shutoff valves.
5. Pressure regulators.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Piping specialties.
2. Corrugated, stainless steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Service meters. Indicate pressure ratings and capacities. Include bypass fittingsbypass fittings and meter bars.
6. Dielectric fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.

B. Deliver pipes and tubes 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.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.5 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide purging and startup of natural-gas supply in accordance with requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 220553 "Identification of Plumbing Piping and Equipment."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with the International Fuel Gas Code.

B. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

2. Service Regulators: 100 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig .

C. Natural-Gas System Pressure within Buildings:

1. Single Pressure: More than 0.5 psig, but not more than 2 psig.
2. Two pressure ranges. Primary pressure is more than 0.5 psig, but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.
3. Two pressure ranges. Primary pressure is more than 2 psig, but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig, but not more than 2 psig.
4. Three pressure ranges. Primary pressure is more than 2 psig, but not more than 5 psig, and is reduced to secondary pressures of more than 0.5 psig, but not more than 2 psig, and is reduced again to pressures of 0.5 psig or less.

D. 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.

2.3 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.

2.4 PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: -mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

2.5 JOINING MATERIALS

A. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

B. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.6 MANUAL GAS SHUTOFF VALVES

A. See "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.

C. Bronze Plug Valves: MSS SP-78.

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. A.Y. McDonald Mfg. Co.
   b. Lee Brass Company.

2. Body: Bronze, complying with ASTM B584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

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. A.Y. McDonald Mfg. Co.
   b. Mueller Co.
   c. Xomox Corporation.

2. Body: Cast iron, complying with ASTM A126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.

9. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80A.

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. Actaris.
   b. American Meter Company.
   c. Dormont; a WATTS brand.
   d. Eclipse Innovative Thermal Technologies.
   e. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
   f. Invensys.
   g. Itron Gas.
   h. Maxitrol Company.
   i. Richards Industries.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: UV-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
9. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

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. Canadian Meter Company Inc.
b. Dormont; a WATTS brand.
c. Eaton.
d. Harper Wyman Co.
e. Maxitrol Company.
f. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: NBR.
6. Seal Plug: UV-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping in accordance with the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for preventing accidental ignition.

3.3 INSTALLATION OF OUTDOOR PIPING

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

D. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

E. Install fittings for changes in direction and branch connections.

F. Install pressure gauge downstream from each service regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."

3.4 INSTALLATION OF INDOOR PIPING

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.

G. Locate valves for easy access. Do not locate valves within return air plenums.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
2. Install sediment trap on both sides of regulators for gas reduction to 2 psig with valve and capped.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gauge downstream from each line regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 INSTALLATION OF SERVICE-METER ASSEMBLIES

A. Install service-meter assemblies aboveground.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 INSTALLATION OF VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

F. Do not install valves in return-air plenums.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.9 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.10 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping is to be one of the following:

1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

2. -temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. -temper copper tube with wrought-copper fittings and brazed joints.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping is to be one of the following:

1. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
4. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground portion of vent pipe and fittings with protective coating for steel piping.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

4. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground portion of vent pipe and fittings with protective coating for steel piping.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG

A. Aboveground Piping: Maximum operating pressure more than 5 psig.

B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.

C. Aboveground, distribution piping is to be one of the following:

1. Steel pipe with steel welding fittings and welded joints.

D. Underground, below building, piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
4. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground portion of vent pipe and fittings with protective coating for steel piping.

3.15 UNDERGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground:

1. NPS 2 and Smaller: Bronze plug valves.
2. NPS 2-1/2 and Larger: Cast-iron, nonlubricated plug valves.

3.16 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter are to be one of the following:

1. Two-piece, -port, bronze ball valves with bronze trim.
2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter are to be one of the following:

1. Two-piece, -port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller are to be one of the following:

1. Two-piece, -port, bronze ball valves with bronze trim.
2. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger are to be one of the following:

1. Two-piece, -port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

E. Valves in branch piping for single appliance are to be one of the following:

1. Two-piece, -port, bronze ball valves with bronze trim.
2. Bronze plug valve.

END OF SECTION

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Piping joining materials.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. Hot-Water Heating Piping: 100 psig at 180 deg F.
2. Chilled-Water Piping: 150 psig at 73 deg F.
3. Condensate-Drain Piping: 150 deg F.

2.2 PIPING JOINING MATERIALS

A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

B. Solder Filler Metals: ASTM B32, lead-free alloys.

C. Flux: ASTM B813, water flushable.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-Water Heating Piping, Aboveground, NPS 2 and Smaller, to Be Any of the Following:

1. , drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
2. Schedule 40, Grade B, steel pipe; Class 125, cast-iron fittings; and threaded joints.

B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 and Larger, to Be Any of the Following:

1. , drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

C. Chilled-Water Piping, Aboveground, NPS 2 and Smaller, to be Any of the Following:

1. , drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

D. Chilled-Water Piping, Aboveground, NPS 2-1/2 and Larger, to Be Any of the Following:

1. , drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

E. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:

1. , drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to the following:

1. Section 230523.11 "Globe Valves for HVAC Piping."
2. Section 230523.12 "Ball Valves for HVAC Piping."
3. Section 230523.13 "Butterfly Valves for HVAC Piping."
4. Section 230523.14 "Check Valves for HVAC Piping."
5. Section 230523.15 "Gate Valves for HVAC Piping."

Q. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

T. Install shutoff valve immediately upstream of each dielectric fitting.

U. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

D. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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 or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.
3. PVC Pressure Piping: Join ASTM D1785 schedule number, PVC pipe, and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings in accordance with ASTM D2855.
4. PVC Nonpressure Piping: Join in accordance with ASTM D2855.

I. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

J. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

K. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions.

L. Mechanically Formed Tee Fittings: Use manufacturer-recommended tools, procedure, and brazed joints.

M. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gauges for HVAC Piping."

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.7 SYSTEM STARTUP

A. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Strainers.
3. Flexible connectors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Automatic Flow-Control 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. Anvil International.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. Bell & Gossett; a Xylem brand.
d. Caleffi North America.
e. Flowcon Americas LLC.
f. Griswold Controls.
g. Hays Fluid Controls.
h. NuTech Hydronic Specialty Products.
i. Oventrop Corporation.
j. Spence Engineering Company, Inc.
k. Tunstall Corporation.
l. Victaulic Company.
m. WATTS.

2. Body: Brass or ferrous metal.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size and Capacity: For each application, provide a valve with rated capacity equal to or greater than capacity of device being served.
6. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.

2.2 STRAINERS

A. Y-Pattern Strainers:

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. Flexicraft Industries.
   b. Flo Fab Inc.
   c. Griswold Controls.
   d. Hays Fluid Controls.
   e. Keckley Company.
   f. Metraflex Company (The).
   g. Victaulic Company.
   h. WATTS.
   i. Zurn Industries, LLC.

2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. CWP Rating: 125 psig.

2.3 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:

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. Flexicraft Industries.
   b. Flo Fab Inc.
   c. Metraflex Company (The).

2. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all piping specialties for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Examine threads on all devices for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 INSTALLATION OF VALVES

A. Install calibrated-orifice balancing valve at each branch connection to return main.

B. Install calibrated-orifice, balancing valve in the return pipe of each heating or cooling terminal.

C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

D. Install pressure-relief and safety-relief valves at hot-water generators and elsewhere as required by ASME BPVC. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC, Section VIII, Division 1, for installation requirements.

3.3 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

1. Provide air outlet drain line full size of air outlet to floor drain or to other point indicated on Drawings.

C. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve full size of separator outlet; extend full size to nearest floor drain.

F. Install expansion tanks having direct air/water interface above the air separator or air purger. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus tank full of water. Do not overload building components and structural members.
3. Install piping from air separator or air purger to expansion tank with a 2 percent upward slope toward tank to avoid air entrapment.

G. Install diaphragm- or bladder-type expansion tanks on the floor.

H. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Prepare valves and specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and other end connections.

C. Use the following precautions during storage:

1. Maintain valve and specialty end protection.
2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASHRAE 15.

B. Comply with ASME B31.5.

C. Test Pressure for Refrigerant R-134a:

1. Suction Tubing Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 115 psig.
2. Suction Tubing for Heat-Pump Applications: 225 psig.
3. Hot-Gas and Liquid Tubing: 225 psig.

D. Test Pressure for Refrigerant R-407C:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 230 psig.

2. Suction Tubing for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Tubing Lines: 380 psig.

E. Test Pressure for Refrigerant R-410A:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 300 psig.
2. Suction Tubing for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Tubing Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: .

B. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

C. Brazing Filler Metals: AWS A5.8M/A5.8.

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

A. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 2 to NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

D. Safety-Relief-Valve Discharge Piping for Conventional Air-Conditioning (Cooling-Only) Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

E. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

F. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 4 and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

G. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 2 to NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

H. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints

I. Safety-Relief-Valve Discharge Piping for Heat-Pump Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install valves in suction and discharge lines of compressor.

B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.

H. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

I. Install receivers sized to accommodate pump-down charge.

J. Install flexible connectors at compressors.

K. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping in accordance with ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

D. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

E. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. long.
2. Roller hangers and spring hangers for individual horizontal runs 20 ft. or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves but not bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Hangers and supports.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" .

B. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."

C. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. Where specified for specific applications, all joints are to be welded.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.

1. Where specified for specific applications, all joints are to be welded.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
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. Sheet Metal Connectors, Inc.
   b. Spiral Manufacturing Co., Inc.

B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.

C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

C. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install fire and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR TYPE 1 COMMERCIAL KITCHEN GREASE HOOD EXHAUST DUCT

A. Install ducts in accordance with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operation"; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" unless otherwise indicated.

B. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

C. All ducts exposed to view are to be constructed of stainless steel as per "Duct Schedule" Article. All ducts concealed from view are to be carbon steel as per "Duct Schedule" Article.

D. All joints are to be welded and are to be telescoping, bell, or flange joint as per NFPA 96.

E. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR EXHAUST DUCTS SERVING COMMERCIAL DISHWASHERS AND OTHER HIGH-HUMIDITY LOCATIONS

A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.

B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch trapped copper drain from each drain pocket to open site floor drain.

C. Minimize number of transverse seams.

D. Do not locate longitudinal seams on bottom of duct.

3.5 ADDITIONAL INSTALLATION REQUIREMENTS FOR LABORATORY EXHAUST AND FUME HOOD EXHAUST DUCTS

A. Install ducts in accordance with NFPA 45, "Fire Protection for Laboratories Using Chemicals."

B. Install exhaust ducts without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to hood or inlet. Where indicated on Drawings, install trapped drain piping.

C. Connect duct to fan, fume hood, and other equipment indicated on Drawings.

3.6 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.8 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint installation requirements.

3.9 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.10 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.11 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.12 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.13 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units :

a. Pressure Class: Positive 1- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

2. Ducts Connected to Constant-Volume Air-Handling Units :

a. Pressure Class: Positive 2- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units :

a. Pressure Class: Positive 3- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

4. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive 2- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units :

a. Pressure Class: Positive or negative 1- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

2. Ducts Connected to Air-Handling Units :

    a. Pressure Class: Positive or negative 2- inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

3. Ducts Connected to Equipment Not Listed above:

    a. Pressure Class: Positive or negative 2- inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units :

    a. Pressure Class: Positive or negative 1- inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 8.
    d. SMACNA Leakage Class for Round and Flat Oval: 8.

2. Ducts Connected to Air-Handling Units :

    a. Pressure Class: Positive or negative 2- inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

3. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive or negative 2- inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:

    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.

3. Stainless Steel Ducts:

    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: galvanized steel coated with zinc chromate.

F. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm or Lower:

      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.

   b. Velocity 1000 to 1500 fpm:

      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

   c. Velocity 1500 fpm or Higher:

      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

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. Control dampers.
2. Turning vanes.
3. Duct-mounted access doors.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 CONTROL DAMPERS

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. American Warming and Ventilating; a Mestek Architectural Group company.
2. Arrow United Industries.
3. Carnes Company.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. Nailor Industries Inc.
7. NCA Manufacturing, Inc.
8. Pottorff.
9. Ruskin Company.
10. Safe Air - Dowco Products.
11. United Enertech.
12. Vent Products Co., Inc.

13. Young Regulator Company.

B. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:

1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:

   a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm.
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Damper Actuator - Electric:

1. Electric - 24 V ac.
2. UL 873, plenum rated.
3. Fully modulating.

   a. Sufficient motor torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
   b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:

   a. Temperature: Minus 40 to plus 130 deg F.
   b. Humidity: 5 to 95 percent relative humidity noncondensing.

6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

2.3 TURNING VANES

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. Ductmate Industries, Inc.
2. DynAir; a Carlisle Company.

3. Elgen Manufacturing.
4. Ward Industries; a brand of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2.4 DUCT-MOUNTED ACCESS DOORS

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. Aire Technologies.
2. Arrow United Industries.
3. Ductmate Industries, Inc.
4. Elgen Manufacturing.
5. Flexmaster U.S.A., Inc.
6. McGill AirFlow LLC.
7. Ruskin Company.
8. United Enertech.
9. Ventfabrics, Inc.
10. Ward Industries; a brand of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. 24-gauge- thick galvanized steel door panel.
d. Vision panel.
e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
f. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum frame.

3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.5 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-ft. spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. For grease ducts, install at locations and spacing as required by NFPA 96.
11. Control devices requiring inspection.
12. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:

1. Two-Hand Access: 12 by 6 inches.
2. Head and Hand Access: 18 by 10 inches.
3. Head and Shoulders Access: 21 by 14 inches.
4. Body Access: 25 by 14 inches.
5. Body plus Ladder Access: 25 by 17 inches.

J. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Install duct test holes where required for testing and balancing purposes.

N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modulating, single-duct air terminal units.
2. Series fan-powered air terminal units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

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. Anemostat Products; a Mestek company.
2. Carnes Company.
3. Carrier Corporation.
4. ENVIRO-TEC; by Johnson Controls, Inc.
5. Johnson Controls.
6. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
7. METALAIRE, Inc.

8. Nailor Industries Inc.
9. Price Industries.
10. Titus, a division of Air System Components; Johnson Controls, Inc.
11. Trane.
12. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.

B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than . Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

D. Electronic Controls:

1. Electronic Damper Actuator: 24 V, .
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to 4 inches wg; includes a multipoint velocity sensor at air inlet.

E. Direct Digital Controls:

1. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controllers, integrated actuators, and room sensors to be furnished under Section 230923 "Direct Digital Controls (DDC) for HVAC."

F. Control Sequence: See Drawings for control sequences.

2.3 SERIES FAN-POWERED AIR TERMINAL UNITS

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. Anemostat Products; a Mestek company.
2. Carnes Company.
3. Carrier Corporation.
4. ENVIRO-TEC; by Johnson Controls, Inc.
5. Johnson Controls.
6. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
7. METALAIRE, Inc.
8. Nailor Industries Inc.
9. Price Industries.
10. Titus, a division of Air System Components; Johnson Controls, Inc.
11. Trane.
12. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.

B. Description: Volume-damper assembly and centrifugal fan in series arrangement inside unit casing with control components inside a protective metal shroud.

1. Designed for quiet operation.
2. Low-profile design.

C. Fan Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Type: Permanent-split capacitor with SCR for speed adjustment.
3. Fan-Motor Assembly Isolation: Rubber isolators.
4. Enclosure Materials: Cast iron.

D. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.08 inch. Include manual air vent and drain valve. Locate coil in discharge outlet airstream. Provide hydronic heating coils for air terminal units scheduled on Drawings.

E. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized in accordance with NFPA 70.
3. Disconnect Switch: Factory-mounted fuse type.

F. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

G. Direct Digital Controls:

1. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal unit manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) for HVAC".

H. Control Sequence: See Drawings for control sequences.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.

B. Install air terminal units according to NFPA 90A.

C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

D. Install wall-mounted thermostats.

3.2 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water and Chilled-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating and cooling coils to supply piping with shutoff valve, strainer, control valve, and union or flange; and to return piping with balancing valve and union or flange.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.8 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

END OF SECTION

SECTION 237313.16 - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

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 insulated, double-wall-casing, indoor, semi-custom air-handling units that are factory assembled using multiple section components, including the following:

1. Fans, drives, and motors.
2. Coils.
3. Air filtration.
4. Air blender.
5. UV-C lamp systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
   a. Include certified fan-performance curves with system operating conditions indicated.
   b. Include certified fan-sound power ratings.
   c. Include fan construction and accessories.
   d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.

7. Include filters with performance characteristics.

8. Include dampers, including housings, linkages, and operators.

1.4 INFORMATIONAL SUBMITTALS

A. Startup service reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 10-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.0033 inch/inch of panel span.

F. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inch wg.

G. Casing shall be thermal break construction, full (R13) 2" thick closed cell foam insulation. Exterior coating surface shall provide a minimum of 2,000hrs Salt Spray rated corrosion resistance (per ASTM B-117).

H. Access Doors - unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged or latched access doors. Doorframe shall be extruded aluminum, with a built in thermal break barrier and full perimeter gasket. Door hinge assembly shall be made of composite material.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements of specifications, capacities, and performance, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carrier Corporation; a unit of United Technologies Corp.

2. Trane.

3. USA Coil & Air.

4. YORK; a Johnson Controls company.

5. VTS.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. niUnit Fans: All fans shall meet the air flow performance specified and shall not exceed the break horsepower or sound power levels specified on the mechanical equipment schedule. Fan performance shall be based on testing and be in accordance with AMCA Standards 210 and 300.

B. Fans:

1. The fan shall include direct driven, arrangement up to 5 plenum fan constructed per AMCA requirements for the duty specified. Fans shall be classified as class II or class III as required; class I fans are not acceptable. Fan wheels shall be made of composite material or aluminum construction and rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor assembly shall include a G90 galvanized steel motor support plate and fan base with internal RIS isolation.

2. All motors shall be standard foot mounted type TEFC selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor, Siemens, Toshiba or WEG that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). Steel cased motors and/or ODP motors are not acceptable. All motors shall include permanently sealed L10-400,000 hr bearings with shaft grounding to protect the motor bearings from electrical discharge due to stray shaft currents. Each fan wheel shall be dynamically balanced to BV-5 or better.

3. Multiple Fan Arrays - Each fan motor shall be individually wired to a control panel containing one VFD per fan with one serving as the primary VFD. Each VFD shall be sized for the HP of the accompanying fan motor contained in the fan array. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards and local code requirements.

C. Variable-Frequency Motor Controller: Serving all fans combined in fan array.

1. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

2. Unit Operating Requirements:

a. Bidirectional autospeed search.
b. Torque boost.
c. Motor temperature compensation at slow speeds.

1) Panel-mounted operator station.
2) Historical logging information and displays.
3) Digital indicating devices.

d. Proportional Integral Directive (PID) control interface.
e. DDC system for HVAC Protocols for Network Communications: ASHRAE 135.

2.4 COIL SECTION

A. Heat Transfer Coils - Water Coils, General:

1. Performance is to be certified under AHRI Standard 410. Coils exceeding the range of AHRI standard rating conditions shall be noted.

2. Single stacked cooling coils shall be mounted on rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all double stacked cooling coils. The intermediate pan shall drain to the main drain pan. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design.

3. Headers are to be seamless copper with die formed tube holes.

4. Connections shall be male pipe thread (MPT) with vent and drain. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 261 PSIG working pressure. Maximum leak tested pressure shall be at least 520 PSIG and maximum burst pressure shall be at least 1,185 PSIG.

5. Water coils shall have the following construction:
   i. 1/2" o.d. x .020" wall copper tube with .020” return bends
   ii. .006" aluminum fins
   iii. Stainless steel casing for 4, 6, and 8 row coils and Galvanized casing for 1, 2, and 3 row coils.

B. Preheat Coils:

1. Hot-Water Coils: .

   a. Piping Connections: Threaded, same end of coil.
   b. Tube Material: Copper.
   c. Coil Working-Pressure Ratings: 200 psig, 325 deg F.

C. Heating Coils:

1. Hot-Water Coils: .

   a. Piping Connections: Threaded, same end of coil.
   b. Tube Material: Copper.
   c. Coil Working-Pressure Ratings: 200 psig, 325 deg F.

D. Cooling Coils:

1. Chilled-Water Coil: .

   a. Piping Connections: Threaded, same end of coil.
   b. Tube Material: Copper.
   c. Working-Pressure Ratings: 200 psig, 325 deg F.
   d. Condensate / Drain Pans - The drain pan shall be fabricated from stainless steel. All pans are to be pitched for complete drainage with no standing water in the unit. Provide stainless steel drain connection extended to the exterior of the casing. All drain connections shall be piped and trapped separately for proper drainage.

2.5 AIR FILTRATION SECTION

A. Filters:

1. Dynamic Air V8 or approved alternate.

2.6 AIR BLENDERS

A. Description: A dynamic air mixing component for the mixing box that integrates OA and RA control dampers for economizing and air flow control into a device that will divide OA and RA into alternating adjacent channels with a control damper located at the end of each channel. These alternating OA and RA dampers will be oriented such that the air leaving an OA damper blade discharges into the air leaving an adjacent RA damper blade for the purpose of mixing OA and RA to eliminate freeze stat trips and to protect coils from freezing in a shorter distance than required by static mixing devices. The product shall be designed to provide freeze protection under the following conditions:

1. Minimum Design Ambient = -15F
2. Design Return Air Temperature = 75F DB / 62F WB
3. CFM = 6,970
4. Min OA CFM = 3640
5. Internal Plenum Height = 39"
6. Internal Plenum Width = 79"

B. Blender Performance:

1. Freeze protection performance will be validated at these conditions in a report using computational fluid dynamics (CFD).
2. CFD report must include ΔP for 100% of nominal CFM air flow through the unit to be channeled through the OA dampers only with the dampers positioned full open.
3. CFD report must include ΔP for 50% of nominal CFM air flow through the RA channels and 50% of nominal CFM air flow through the OA channels with the dampers positioned full open.
4. Maximum Rated Pressure: 4” w.c.
5. Maximum Rated Velocity: 3000 fpm

C. Blender Construction:

1. Channel walls separating OA and RA sections must be insulated to prevent condensation with RA conditions of 75°F and 65% RH and OA at Minimum Design Ambient.
2. Channel structure must not be permanently deformed or the function of the dampers impacted by a ΔP = 4” w.c. between the RA and OA channels.
3. Damper frame is .080” Aluminum secured to the Channel Blender structure to prevent racking.
4. Dampers will be Class 1A low leakage dampers with 3 cfm/ft^2 of allowable leakage at 1” w.c. ΔP.

5. Dampers are extruded aluminum with EPDM seals mechanically secured into the damper blade.

6. OA and RA dampers to be independently controlled by separate actuators.

7. Damper actuators shall be serviceable.

8. Damper actuators shall be selected to provide 8 in-lb torque for each square foot of damper surface area.

9. Damper actuators shall be compatible with a 1" jackshaft.

10. Material: Aluminum.

2.7 UV-C LAMP SYSTEMS

A. Description:

1. UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, and lamp holder used for UV germicidal irradiation of cooling coil and condensate drain pan.

2. Factory installed and preengineered.

B. Standard: UL Category Code ABQK, HVAC accessories, air-duct mounted.

C. Lamps: High output, hot cathode, T5 diameter. Single-ended emitter shall operate in air velocities of up to 2,000 fpm and air temperatures of 35-140F. Lamp shall produce zero ozone or other secondary contaminants.

D. Lamp-Holder Construction:

1. UV- and moisture-resistant materials and designed to connect the lamp to the plug.

2. Adjustable positioning.

E. Lamp-Clamp Construction:

1. UV- and moisture-resistant materials, water-tight connection.

2. Adjustable positioning.

F. Lamp Protection: Hermetically sealed to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.

G. Lamp Output: UV-C energy, primarily at the 254-nm wavelength with a 360-degree energy distribution. The unit shall be tested by an independent test laboratory and shall be verified to provide output per one inch arc length of not less than 7.8 µW/cm2 at 1 meter in a 400 fpm airstream of 50 °F.

H. Access Door Interlocks: Automatic disconnect on all access doors into UV-installed casing sections to shield servicing personnel from contact with light.

I. Power Consumption: Maximum of 15 W/sq. ft..

2.8 DAMPERS

A. Dampers to be airfoil, opposed blade type. Frame and dampers to be constructed out of extruded 6060-T66 aluminum. Damper blades to be connected by FRP nylon infused gears for long life. Dampers to have square actuator shaft to prevent actuator slippage. Dampers to be AMCA certified.

2.9 AIRFLOW AND PRESSURE MEASUREMENT SYSTEMS

A. Airflow Sensors:

1. Fan/Fan Array: Fan manufacturer shall provide airflow measurement pressure taps for each individual fan. If pressure taps are not available for the fans being supplied, the use of Pitot-type fan inlet airflow sensors is acceptable. Basis-of-Design Product: Provide Paragon Controls Inc.; FE-1050 or equal.

2. Outside Air Intake/Duct Systems: Airflow stations shall consist of multiple Pitot-type airflow sensors, factory mounted and pre-piped in a casing designed for flanged connection to ductwork, control dampers, louvers, etc. Sensor density shall comply with ANSI/ASHRAE Standard 111 for equal area traversing. Airflow stations with low sensor densities such as thermal dispersion and single or dual point differential pressure sensors are not acceptable. Basis-of-Design Product: Provide Paragon Controls Inc.; FE-1500 or equal.

B. Airflow/Pressure Transmitters: Each transmitter shall be designed to measure, sum, and report the flow rate of up to three systems (such as supply air, return air, and outside air) with up to ten flow sensing points (such as fans/fan arrays, outside air intakes, and duct systems) and measure up to four additional independent differential pressure sensing points (such as pressure drop across filters or coils, duct static pressure, and plenum pressure) with an accuracy of ±0.50% of full scale. The transmitter shall be housed in a hinged compact NEMA4X enclosure to provide flexibility in mounting location. Transmitter shall include a color touchscreen with on-screen keypad and setup wizard allowing for simple field configuration when required. Connection to the airflow sensor shall be by plenum tubing; flow sensors requiring transmitter connection using proprietary electrical cabling are prohibited. The total (summed) airflow rate for each system shall be available to the Building Management System (BMS) or local controller via dedicated field selectable 0 to 10 VDC or 4 to 20 mA analog outputs and via field selectable BACnet®-MS/TP Master or Modbus®RTU Slave network communications. Independent flow and pressure values for each of the ten sensing points shall also be available to the BMS or local controller via network communication. Transmitter software shall be upgradeable using MicroSD card or USB device. Basis-of-Design Product: Provide Paragon Controls Inc.; MTSE or equal.

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 casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

G. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.

6. Verify that zone dampers fully open and close for each zone.

7. Verify that face-and-bypass dampers provide full face flow.

8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.

9. Comb coil fins for parallel orientation.

10. Verify that proper thermal-overload protection is installed for electric coils.

11. Install new, clean filters.

12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.

2. Measure and record motor electrical values for voltage and amperage.

3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

END OF SECTION - 237313.16

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: Five year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

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. Lennox Industries, Inc.; Lennox International.

2. Mitsubishi Electric & Electronics USA, Inc.

3. Samsung HVAC.

4. YORK; a Johnson Controls company.

5. GREE.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.

3. Retain "Electric Coil" Subparagraph below for heat-pump units and supplemental electric heat.

4. Fan: Direct drive, centrifugal.

5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.
d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
f. Mount unit-mounted disconnect switches on exterior of unit.
g. .

6. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 1 inch deep.

7. Air Filtration Section:

a. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.
2) Thickness: 1 inch.
3) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
4) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Fan: Aluminum-propeller type, directly connected to motor.

4. Motor: Permanently lubricated, with integral thermal-overload protection.

5. Low Ambient Kit: Permits operation down to 45 deg F.

6. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

3. Retain one of two subparagraphs below. Retain first for projects in seismic areas; retain second for projects not in seismic areas. Indicate vibration isolation and seismic-control device type and minimum deflection in supported equipment schedule on Drawings.

4. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

5. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

2. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE

A. The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections.

1.2 REFERENCE STANDARDS

A. ANSI American National Standards Institute

B. ASTM American Society for Testing and Materials

C. EPA Environmental Protection Agency

D. ETL Electrical Testing Laboratories, Inc.

E. IEEE Institute of Electrical and Electronics Engineers

F. IES Illuminating Engineering Society

G. ISA Instrument Society of America

H. NBS National Bureau of Standards

I. NEC National Electrical Code

J. NEMA National Electrical Manufacturers Association

K. NESC National Electrical Safety Code

L. NFPA National Fire Protection Association

M. NRTLNationally Recognized Testing Laboratory

N. UL Underwriters Laboratories Inc.

O. NECA National Electrical Contractor's Association

1.3 REGULATORY REQUIREMENTS

A. All work and materials are to conform in every detail to applicable requirements contained within the latest adopted editions of the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, and the National Electrical Safety Code as well as the present manufacturing standards (including NEMA).

B. All Division 26 work shall be done under the direction of a Master Electrician currently licensed in the project's jurisdiction.

C. All Division 26 work shall be installed in accordance with the latest applicable NECA Installation Standards.

D. All Division 26 work shall be in accordance with all applicable local, state, and federal laws, ordinances, and rules.

1.4 QUALITY ASSURANCE

A. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space, and for obtaining the performance from the system into which these items are placed.

B. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

C. All materials shall be listed by and shall bear the label of an approved Nationally Recognized Testing Laboratory (NRTL) as identified by the United States Occupational Safety and Health Administration (OSHA), per the OSHA Nationally Recognized Testing Laboratory Program. If none of the approved electrical testing laboratories has published standards for a particular item, then other applicable national independent testing standards, if available and approved by the engineer, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, shall be so labeled.

D. The electrical contractor performing the electrical work under Division 26 shall:

1. Be currently licensed to perform such electrical work within the jurisdiction containing the project site.
2. Have at least 5 years of documented experience working on similar projects of similar size and complexity.

E. The Electrical Foreman and/or Superintendent managing the electrical installation for the electrical contractor shall:

1. Be currently licensed as a Master Electrician (or equivalent) in the jurisdiction of the project site.
2. Have at least 3 years of documented experience managing similar electrical installations of similar size and complexity.

F. Source Limitations:

1. Unless noted otherwise, electrical equipment, devices, and components of the same type shall be through one source from a single manufacturer.

G. The firm selected to perform X-ray analysis of structural members prior to cutting or drilling shall specialize in this service and have at least 5 years of professional experience.

1.5 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

A. No outages shall be permitted on existing systems except at the time and during the interval specified by the owner. The contractor shall provide a minimum of a (7) day notice prior to any scheduled shutdown of power to any portion of the electrical distribution system. The contractor shall receive written approval from the owner or the owner's representative prior to initiating an electrical shutdown. Any outage must be scheduled when the interruption causes the least interference with the owner's normal schedules and business routines. No extra costs shall be paid to the contractor for such outages which must occur outside of regular weekly working hours.

B. This contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.

1.6 APPROVED ELECTRICAL TESTING LABORATORIES

A. The following laboratories are approved for providing electrical product safety testing, listing, and labeling services as required in these specifications:

1. A Nationally Recognized Testing Laboratory (NRTL) as identified by the United States Occupational Safety and Health Administration (OSHA), per the OSHA Nationally Recognized Testing Laboratory Program.

1.7 SLEEVES AND OPENINGS

A. In cases where contractor requires sleeved openings, the contractor shall furnish all sleeves required for their penetrations and shall be responsible for providing the respective openings. Contractor shall coordinate sleeves and openings.

B. Openings shown on the structural and/or architectural drawings shall be the responsibility of the contractor. Contractor shall furnish and install the sleeves for openings shown on the structural and/or architectural drawings.

C. Openings that are required and are not shown on the structural and/or architectural drawings shall be the responsibility of the contractor. The contractor shall install sleeves for these openings or cut openings as needed (including floor openings within chases).

D. Individuals skilled in such work shall accomplish installation of sleeves and openings.

E. Contractor shall be responsible for coordinating locations of the sleeves with work of other trades.

F. Contractor shall submit to the Architect/Engineer for review and approval, layout drawings of all required sleeves and/or openings. Sleeve and opening layout drawings shall be received by the Architect/Engineer a minimum of two weeks prior to installation of the sleeves and openings. Sleeve and opening sizes and locations shall be dimensioned from column lines and floor elevations or from a point of reference approved by the Architect/Engineer.

1.8 SEALING AND FIRE STOPPING

A. Sealing and fire stopping of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Division 07.

B. All Division 26 related fire stop penetrations through rated walls shall be documented and labeled. See the submittal requirements herein for further details.

1.9 OWNER FURNISHED EQUIPMENT

A. In some cases, certain equipment might be identified in other areas of the contract documents as being owner furnished. In such cases the contractor shall be responsible for the following unless noted otherwise.

1. Receiving the owner furnished equipment.
2. Storing owner furnished equipment.
3. Installing owner furnished equipment.
4. Making final connections to owner furnished equipment.
5. Protecting owner furnished equipment from damage.

B. The contractor shall be responsible for all costs associated with any damage to the owner furnished equipment from the time it is received by the contractor until such time that the owner takes beneficial occupancy.

1.10 WORK BY OTHERS ON BEHALF OF THE OWNER

A. In some cases, certain work might be identified in other areas of the contract documents as being the responsibility of the Owner or a third party working on behalf of the Owner. In such cases, the contractor shall:

1. Allow access to the project site so that the Owner or their third party can accomplish their work as defined in the contract documents.
2. Coordinate with the Owner and/or their third party regarding the scheduling of the work.

1.11 INTENT

A. The contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.

B. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications, within the Drawings, or between the Specifications and the Drawings, the most stringent requirement shall apply.

C. It shall be understood that the details and drawings are diagrammatic. The contractor shall verify all dimensions at the site and be responsible for their accuracy.

D. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to Owner's (or their authorized representative's) inspections, tests and approval from the commencement until the acceptance of the completed work.

E. Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

1.12 OMISSIONS

A. No later than ten (10) days before bid opening, the contractor shall call the attention of the Architect/Engineer to any materials or apparatus the contractor believes to be inadequate and to any necessary items of work omitted.

1.13 SUBMITTALS

A. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the contractor for correction and resubmission. Failing to follow these instructions does not relieve the contractor from the requirement of meeting the project schedule.

B. On request from the Engineer, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.

C. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.

D. The submittals must be approved before fabrication is authorized.

E. Unless noted otherwise, submit sufficient quantities of submittals to allow the following minimum distribution.

1.	Operating and Maintenance Manuals	2 copies
2.	Owner	1 copy
3.	A/E	1 copy

1.14 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Architect/Engineer before proceeding.

C. Tools, materials, and equipment shall be confined to areas designated by the Owner or the Owner's authorized representative.

1.15 WORK SEQUENCE AND SCHEDULING

A. Install work in phases as required to accommodate owner's occupancy requirements. During the construction period coordinate electrical schedule and operations with owner's representative.

1.16 WORK BY OTHER TRADES

A. Every attempt has been made to indicate in this trade's specifications and drawings all work required. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.

B. Electrical details on drawings for equipment to be provided are based on preliminary design data only. Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided. This includes a requirement for the contractor to coordinate between trades.

1.17 OFFSITE STORAGE

A. Prior approval by the owner and the A/E shall be required. The contractor shall submit a list of materials to be considered for off-site materials storage. In general, building wire, conduit, fittings, and similar rough-in material will not be accepted for off-site storage. No material will be accepted for off-site storage unless shop drawings for the material have been approved.

B. Off-site warehouse storage space shall be insured such that the materials stored are insured to the same level as materials stored on the project site. Proof of off-site warehouse space storage insurance shall be submitted for approval prior to the storage of any materials off-site.

1.18 SALVAGE MATERIALS

A. No materials removed from this project shall be reused unless specifically noted otherwise. All materials removed shall become the property of and shall be disposed of by the contractor, unless noted otherwise.

B. Existing materials and/or equipment specifically identified within the contract documents as being for salvage shall be carefully removed and handed over to the owner at a site selected by the owner. The contractor shall coordinate all items to be salvaged with the owner prior to the start of any demolition work.

1.19 CERTIFICATES AND INSPECTIONS

A. Obtain and pay for all required construction permits and installation inspections required by local, state, and federal laws, codes, and ordinances.

B. The qualified licensed Electrical Contractor is responsible for coordination of the required electrical inspections with both the owner and the Authority Having Jurisdiction (AHJ). The Electrical Contractor shall be present when the AHJ conducts the electrical inspections.

1.20 OPERATION AND MAINTENANCE DATA

A. All operations and maintenance data shall comply with the submission and content requirements specified under Division 01.

B. In addition to the general content specified under Division 01 supply the following additional documentation:

1. Manufacturer's wiring diagrams for electrically powered equipment.

1.21 RECORD DRAWINGS

A. The Contractor shall always maintain at least one up to date copy each of the specifications and drawings on the job site.

B. The Contractor shall have on the job site a separate suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. Dimensions and elevations on the record drawings shall locate all buried or concealed piping, conduit, or similar items. This set shall be considered the dedicated red line markup record drawing set for the project

C. The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.

D. At completion of the project, the Contractor shall submit the marked-up record drawings to the Architect/Engineer prior to final payment.

1.22 ACTION SUBMITTALS

A. Submittal Schedule for Division 26

1. Provide complete submittal schedule for all required submittals associated with Division 26. This schedule shall include:

a. A line item breakdown of each individual submittal required as part of the overall Division 26 submittal effort.
b. The associated specification section and specific technical and/or informational content of each individual submittal required.
c. The planned date for each individual electrical submission to the engineer.
d. A list of any specific Division 26 submittal requirements that the contractor believes are not required for this project.

2. **The Division 26 Submittal Schedule must be approved by the engineer before any other Division 26 submittals will be reviewed. Failure to comply with the Division 26 Submittal Schedule requirement shall not relieve the contractor of their schedule responsibilities on the project.**

B. Fire stop label sample for approval by architect and engineer.

C. Coordination Drawings:

1. For sleeves and openings.
2. For all access panels required as part of Division 26. Access panels shall be submitted to both the architect and the engineer for approval.

D. Proposed Electrical Shutdown Schedule

1. Indicated the quantity, extent, and timing of all planned electrical shutdowns associated with the project.

1.23 INFORMATIONAL SUBMITTALS

A. Qualification Data

1. Electrical Contractor qualifications data
2. Electrical Superintendent/Foreman qualifications data
3. X-ray Analysis Firm

B. Request for Stored Materials

C. Insurance for Off-Site Storage Facility for Stored Materials

1.24 CLOSEOUT SUBMITTALS

A. Color copy of contractor's red line record drawing markup.

B. Operation and Maintenance Data

1. O&M Data covered under other Division 26 specification sections.
2. Fire Stop O&M Data

a. Present in the form of a three-ring binder or a pdf file on electronic media.
b. Shall include the following for each individual fire stop penetration associated with Division 26.

1) A label for the penetration that gives the penetration a unique identifier alpha-numeric number, the location of the penetration, the date of installation, the installing contracting firm's name, the installer's name, and the UL listed fire stop solution being utilized.
2) A photo of the individual penetration with the permanent label applied next to the penetration (both sides).

PART 2 - PRODUCTS

2.1 ACCESS PANELS AND DOORS

A. Lay-in Ceilings:

1. Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration provided under other divisions are sufficient; no additional access provisions are required unless specifically indicated.

B. Plaster Walls and Ceilings, Concealed Cavities:

1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers and similar wet areas, concealed hinges, screwdriver operated cam latch for general application, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size 8" x 8".

2.2 IDENTIFICATION

A. Reference Section 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS.

2.3 SEALING AND FIRE STOPPING

A. Fire and/or Smoke Rated Penetrations:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Division 07

B. Non-Rated Penetrations:

1. Conduit Penetrations Below Grade:

a. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or water-stop type wall sleeve.

2. Conduit and Cable Tray Penetrations Above Grade:

a. At through-wall conduit and cable tray penetrations of non-rated interior and exterior walls, and floors, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 - EXECUTION

3.1 ELECTRICAL DEMOLITION WORK

A. If electrical demolition work is included in the project scope, then the contractor shall:

1. Remove electrical equipment, devices, light fixtures, components, conduit, wiring, etc. as indicated on the drawings.
2. Remove conductors to be demolished all the way back to their logical source, unless noted otherwise.
3. Remove conduit to be demolished all the way back to their logical source, unless noted otherwise.
4. Cut off and seal at grade or finished floor any underground conduits that are associated with circuits and/or conduit runs that are to be demolished, unless otherwise noted.
5. Provide temporary and/or permanent power as required to maintain power to electrical equipment, devices, light fixtures, components, etc. that are to remain when they will be disconnected as the result of demolition work.
6. Minimize the length of any disruptions of electrical power associated with the electrical demolition process.
7. Dispose of all demolished materials in accordance with all applicable federal, state, and local laws/ordinances.

3.2 TEMPORARY POWER, LIGHTING, AND TELECOMMUNICATIONS

A. Unless noted otherwise, the following shall apply in regarding temporary project site power, lighting, and telecommunications.

1. Contractor shall provide temporary power and lighting to the project site as required for the duration of the project.
2. Contractor shall be responsible for temporary power and telecommunications connections to any temporary job site office facilities.
3. Contractor shall be responsible for all utility fees and permits associated with the temporary power for the project site during the project.
4. Contractor shall be responsible for all telecommunications utility fees associated with the temporary job site office facilities.
5. At the conclusion of the project, the contractor shall remove all elements of the temporary power, lighting, and telecommunications systems at the project site.
6. All temporary power, lighting, and telecommunications work shall be in accordance with the latest adopted version of NFPA 70.

3.3 EXCAVATION AND BACKFILL

A. Perform all excavation and backfill work to accomplish indicated electrical systems installation unless noted otherwise.

3.4 CONCRETE WORK

A. Contractor shall perform all cast-in-place concrete unless noted otherwise. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.

3.5 CUTTING AND PATCHING

A. Cutting and patching required to access work in existing walls, in chases, above inaccessible ceilings, below floors, etc., shall be the responsibility of the Contractor unless noted otherwise.

B. The Contractor shall do all cutting or fitting of the work as required to make its several parts fit together, or to receive the work of others, as shown or reasonably implied by the drawings or specifications. Holes cut in exterior walls and/or roofs shall be waterproofed.

C. Whenever the Contractor cuts for required access to work, the contractor shall also be responsible for patching. Where cutting and patching is required, Contractor shall hire individuals skilled in such work to do cutting and patching.

D. Unless noted otherwise, whenever the Contractor removes or relocates building components and as a result leaves a remaining opening, the contractor shall be responsible for patching the opening. Where building components are removed by an Asbestos Abatement Contractor on behalf of a Contractor, the Contractor shall be responsible for patching the remaining opening.

E. Patching includes repairing openings to match adjacent construction and painting the surface to match existing. Painting means covering the entire wall where patching is to be done to nearest break point or corner unless noted otherwise.

F. Contractor shall not endanger any work by cutting, digging or otherwise and shall not cut or alter the work of others without their consent.

G. Do not pierce beams or columns without permission of the Structural Engineer and then only as directed in writing. If any ductwork, piping, conduit, etc. is required through walls or floors where no sleeve has been provided, use a core drill or saw cut to prevent damage and structural weakening.

H. Prior to cutting or drilling through an existing structural slab or wall, the contractor, at their sole cost, shall obtain the services of a firm that specializes in X-raying structural members to confirm that no structural elements will be impacted. The results of the X-ray analysis shall be submitted for review by the Structural Engineer. No cutting or drilling shall commence without written authorization from the Structural Engineer.

I. Wherever any material, finish, or equipment, is damaged by the contractor, the contractor shall be responsible for the timely repair or replacement at the sole cost of the contractor. The A/E reserves the right to disallow any means and/or methods that, in the opinion of A/E, are harmful to and/or not in the best interest of preserving the improvements receiving the work.

3.6 BUILDING ACCESS

A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by the contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.7 EQUIPMENT ACCESS

A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the various trades, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish and install access panels as required.

3.8 COORDINATION

A. The Contractor shall coordinate all trades and the owner's representative in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.

C. Coordinate all work among various trades prior to installation. Any installed work that is not coordinated and that interferes with other work shall be removed or relocated at the contractor's expense.

3.9 SLEEVES AND OPENINGS

A. Conduit penetrations in new poured concrete horizontal construction requiring F and T rating: Form opening using hole form or core drill opening (with Structural Engineer's written permission). Alternatively provide cast in place fire stopping devices/sleeves.

B. Conduit penetrations in new poured concrete horizontal construction requiring F rating but no T rating: Same as conduit penetrations in new poured concrete construction requiring F and T ratings except that schedule 40 steel pipe sleeves may also be used.

C. Conduit penetrations in new poured concrete horizontal construction that do not require F or T ratings: Provide schedule 40 steel pipe sleeve, form opening using hole form or core drill opening (with Structural Engineer's written permission).

D. Conduit penetrations in existing concrete floors: Core drill openings (with Structural Engineer's written permission).

E. Conduit penetrations through existing floors located in food service areas that do not require a T rating: Core drill sleeve opening large enough to insert schedule 40 sleeve (with Structural Engineer's written permission), extend sleeve 2 inches above the floor and grout area around sleeve with hydraulic setting, non-shrink grout.

F. Where penetrating conduit weight is supported by floor, provide manufactured product or structural bearing collar designed to carry load.

3.10 SEALING AND FIRE STOPPING

A. Fire and/or Smoke Rated Penetrations:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Division 07. All fire stopping solutions shall be UL listed.

B. Non-Rated Penetrations

1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions. Install so that the bolts used to tighten the seal are accessible from the interior of the building or vault.
2. At all interior and exterior walls, through-wall conduit penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the sleeve or cored opening and the conduit is completely blocked.

C. Penetrations Subject to Water Intrusion:

1. For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:

   a. Conduit penetration where steel pipe sleeve is used extend steel sleeve 2" above the floor.
   b. Conduit penetration where cast in place fire stopping device/sleeve is used, extend device/sleeve 2" above the floor (provided it meets the device's UL listing).
   c. Conduit penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2" x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8"on center. Seal corners water-tight with urethane caulk.

2. Floors subject to water intrusion or rooms housing electrical equipment include the following locations:

a. Food Service/Kitchen Areas
b. Walk-In Coolers/Freezers
c. Restrooms
d. Locker/Shower Rooms
e. Janitor Rooms w/ Sinks
f. Mechanical/Plumbing Equipment Rooms
g. Maintenance/Industrial Shops
h. Data/Telecommunications Rooms
i. Electrical Equipment Rooms

3. Provide waterproof caulk sealant top coating on fire stopping system (or other approved means to protect the fire stopping system from water) in areas subject to wash down such as Food Service and Dish Washing Areas.

3.11 HOUSEKEEPING AND CLEAN UP

A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material, and equipment, etc., from the site.

END OF SECTION

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Connectors, splices, and terminations rated 600 V and less.

1.2 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances.

B. VFC: Variable-frequency controller.

C. NECA: National Electrical Contractors Association

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer's authorized service representative.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. 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. Alpha Wire Company.
2. American Bare Conductor.
3. American Insulated Wire
4. Belden Inc.

5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Service Wire Co.
8. Southwire Company.
9. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. 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. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Service Wire Co.
7. Southwire Company.
8. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multicircuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Bare.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.

H. Armor: Steel or Aluminum, interlocked.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. 3M Electrical Products.
2. AFC Cable Systems; a part of Atkore International.
3. Gardner Bender.
4. Hubbell Power Systems, Inc.
5. Ideal Industries, Inc.
6. ILSCO.
7. NSi Industries LLC.
8. O-Z/Gedney; a brand of Emerson Industrial Automation.
9. Service Wire Co.
10. TE Connectivity Ltd.
11. Thomas & Betts Corporation; A Member of the ABB Group.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded and shielded or VFD-rated for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, or better, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, or better, single conductors in raceway .

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, or better, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, or better, single conductors in raceway.

E. Exposed Branch Circuits: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, or better, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

H. VFC Output Circuits: Type XHHW-2 in metal conduit, or VFD-rated cable.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Install wire, cable and connector products in accordance with the manufacturer's written instructions, the applicable requirements of the NFPA 70 and in accordance with recognized industry practices, such as NECA, to ensure the installed products serve the intended function.

B. Unless noted otherwise, minimum wire size for installation shall be #12 AWG. All branch circuits shall consist of dedicated neutrals. Neutral conductors shall not be shared between separate ungrounded branch circuit conductors.

C. Provide conductor(s) of size, rating and type indicated for each service. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements.

D. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

E. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

F. 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.

G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

I. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 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-486B.

B. Make splices, terminations, and taps that are compatible with conductor material.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
b. Test bolted connections for high resistance using one of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and testing agency's field supervisor.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. 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.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 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. Burndy; Part of Hubbell Electrical Systems.
2. ERICO International Corporation.
3. Harger Lightning & Grounding.
4. O-Z/Gedney; a brand of Emerson Industrial Automation.
5. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

D. Lead Content: Less than 300 parts per million.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

H. Straps: Solid copper, copper lugs. Rated for 600 A.

I. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated or stainless-steel bolts.

a. Material: Die-cast zinc alloy.

J. Lead Content: Less than 300 parts per million.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, as indicated on sheets. .

1. Bury at least 30 inches below grade.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors 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 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

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.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting 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 same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer 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.

4. Prepare dimensioned Drawings locating each test well, 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.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

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 the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

B. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.

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 Rating: Class 1.
2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

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. Allied Tube & Conduit; a part of Atkore International.
   b. B-line, an Eaton business.
   c. ERICO International Corporation.
   d. Flex-Strut Inc.
   e. Gripple Inc.
   f. GS Metals Corp.
   g. G-Strut.
   h. Haydon Corporation.
   i. Thomas & Betts Corporation; A Member of the ABB Group.
   j. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel .
4. Channel Width: 1-5/8 inches .
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   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) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.

3) MKT Fastening, LLC.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   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) B-line, an Eaton business.
      2) Hilti, Inc.
      3) ITW Ramset/Red Head; Illinois Tool Works, Inc.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125/F 3125M,Grade A325.
6. Toggle Bolts: All -steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

   1. NECA 1.
   2. NECA 101
   3. NECA 102.
   4. NECA 105.
   5. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION - 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.3 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

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. Allied Tube & Conduit; a part of Atkore International.
b. Republic Conduit.
c. Thomas & Betts Corporation; A Member of the ABB Group.
d. Wheatland Tube Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

a. Comply with NEMA RN 1.
b. Coating Thickness: 0.040 inch, minimum.

6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel or aluminum.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal 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. Allied Tube & Conduit; a part of Atkore International.
b. Republic Conduit.
c. Thomas & Betts Corporation; A Member of the ABB Group.
d. Western Tube and Conduit Corporation.

2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: compression.

6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

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. AFC Cable Systems; a part of Atkore International.
   b. CANTEX INC.
   c. Thomas & Betts Corporation; A Member of the ABB Group.

2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

B. Nonmetallic 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. AFC Cable Systems; a part of Atkore International.
   b. CANTEX INC.
   c. Thomas & Betts Corporation; A Member of the ABB Group.

2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for RNC: Comply with NEMA TC 3; match to conduit type and material.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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. B-line, an Eaton business.
2. Hoffman; a brand of Pentair Equipment Protection.
3. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 Type 3R Type 4 Type 12 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

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. Crouse-Hinds, an Eaton business.
2. EGS/Appleton Electric.
3. Hubbell Incorporated.
4. RACO; Hubbell.
5. Thomas & Betts Corporation; A Member of the ABB Group.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.

J. Gangable boxes are allowed.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 Type 3R Type 4 Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 Type 3R Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:

   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: Insert temperature temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set metal floor boxes level and flush with finished floor surface.

GG. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified.

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified.
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION - 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.

1.2 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

1.4 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

C. 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. Allied Tube & Conduit; a part of Atkore International.
2. O-Z/Gedney; a brand of Emerson Industrial Automation.
3. Republic Conduit.
4. Thomas & Betts Corporation; A Member of the ABB Group.
5. Western Tube and Conduit Corporation.
6. Wheatland Tube Company.

D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. 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. ARNCO Corp.
2. Beck Manufacturing.
3. CANTEX INC.
4. CertainTeed Corporation.
5. Condux International, Inc.
6. Crown Line Plastics.
7. ElecSys, Inc.
8. Electri-Flex Company.
9. Endot Industries Inc.
10. IPEX USA LLC.
11. Lamson & Sessions.
12. Manhattan/CDT.

13. National Pipe & Plastics.
14. Opti-Com Manufacturing Network, Inc (OMNI).
15. Spiraduct/AFC Cable Systems, Inc.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

A. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and 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 and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain. Remove and stockpile topsoil for reapplication .

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.

B. Underground Ducts Crossing Roadways: Type EPC-40 PVC RNC, encased in reinforced concrete.

C. Stub-ups: Concrete-encased GRC or PVC-coated GRC.

3.3 EARTHWORK

A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.

3.4 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

I. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

J. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.

K. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms.
3. Width: Excavate trench 12 inches wider than duct on each side.
4. Width: Excavate trench 3 inches wider than duct on each side.
5. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
6. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. 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.
8. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
9. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
10. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inchesfrom conduit side to edge of slab

11. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
12. 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.
13. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.

14. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

15. Pouring Concrete: Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

L. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally. Provide red warning tape.

3.5 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.7 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION - 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Cable ties.
5. Paint for identification.
6. Fasteners for labels and signs.

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 electrical identification products.

B. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

C. Comply with ANSI Z535.4 for safety signs and labels.

D. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

3. Colors for 480/277-V Circuits:

   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.

4. Color for Neutral: White or gray.
5. Color for Equipment Grounds: Green.

C. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

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. Brady Corporation.
   b. Champion America.
   c. emedco.
   d. Grafoplast Wire Markers.
   e. HellermannTyton.
   f. LEM Products Inc.
   g. Marking Services, Inc.
   h. Panduit Corp.
   i. Seton Identification Products.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

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. Brady Corporation.
b. HellermannTyton.
c. Marking Services, Inc.
d. Panduit Corp.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."

M. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

N. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

END OF SECTION 260553

SECTION 260573.13 - SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

B. This study shall be complete, including all electrical gear, throughout the entire facility.

C. A preliminary short-circuit and overcurrent protection device coordination study shall be performed prior to contractor ordering electrical equipment including but not limited unit substations, transfer switches, switchgear and panelboards.

1. This study shall verify all contractor selected electrical equipment meets specified short circuit interrupting current values.
2. The contract documents shall be used to estimate branch and feeder circuits lengths to determine required equipment interrupting capacities.
3. The infinite bus method shall be utilized for determining maximum available fault current available at the utility service unless noted otherwise.
4. This study shall verify selective coordination can be maintained for contractor selected circuit breakers as required by NFPA 70 Article 700 and 701.
5. Any changes from the specified equipment as determined from this preliminary study shall be brought to the attention of the Architect prior to ordering of equipment.
6. Preliminary values shall be provided to the Owner and Architect for review. These values shall include:

    a. Short circuit study data
    b. List of potential over-dutied electrical equipment busses and overcurrent protection devices.
    c. Coordination curves with preliminary recommended settings for any overcurrent protective devices impacted by the requirements of NFPA 70 Articles 700 and 701.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

a. Short-circuit study input data, including completed computer program input data sheets.
b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power System Analysis Specialist.
2. For Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
2. The following are from the Short-Circuit Study Report:

    a. Final one-line diagram.
    b. Final Short-Circuit Study Report.
    c. Short-circuit study data files.
    d. Power system data.

1.6 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices 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.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.

E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

F. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

G. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

H. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION - 260573.13

SECTION 260573.16 - COORDINATION STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

B. This study shall be complete, including all electrical gear, throughout the entire facilitywhether.

1.2 DEFINITIONS

A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

D. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

F. SCCR: Short-circuit current rating.

G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

H. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

a. Coordination-study input data, including completed computer program input data sheets.
b. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Specialist.
2. For Field Adjusting Agency.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. The following are from the Coordination Study Report:

a. Final one-line diagram.
b. Final protective device coordination study.
c. Coordination study data files.
d. List of all protective device settings.
e. Time-current coordination curves.
f. Power system data.

1.6 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. SKM Systems Analysis, Inc.

B. Comply with IEEE 242 and IEEE 399.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer 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 and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.

2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Any revisions to electrical equipment required by the study.
7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, and ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

a. Power utility's overcurrent protective device.
b. Medium-voltage equipment overcurrent relays.
c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f. Cables and conductors damage curves.
g. Ground-fault protective devices.
h. Motor-starting characteristics and motor damage points.
i. Generator short-circuit decrement curve and generator damage point.
j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Provide adequate time margins between device characteristics such that selective operation is achieved.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other 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.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
    k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

A. Contractor shall provide recommendations to input values in adjustable circuit breakers. If there are any modifications needed to reduce arc-flash, bring to Owner’s attention. Changes that are no-cost should be implemented unless it hinders operation of equipment connected. Reports to be turned over (printed and software) to the Architect and Owner.

B. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

C. Fuse - Low Voltage Breaker coordination requires that the down-line breaker maximum time curve be less than 75% of the minimum melt time of the up-line fuse curve to account for pre-loading.

D. Low Voltage Breaker - Fuse coordination requires a minimum 0.1 second time margin between the curves to allow for temperature variations in the fuse.

E. Low Voltage Breaker - Low Voltage Breaker coordination requires only that the plotted curves do not intersect since all tolerances and operating times are included in the published characteristics.

F. Systems must selectively coordinate to the values indicated below unless local amendments to the National Electrical Code require a different value.

1. Emergency (NEC article 700) 0.01 seconds.

2. Optional Standby (NEC article 702) 0.1 seconds.

3. Normal Power Systems 0.1 seconds.

G. Comply with IEEE 399 for general study procedures.

H. Base study on device characteristics supplied by device manufacturer.

I. Begin analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.

J. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

K. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

L. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.

M. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

N. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

O. Include the ac fault-current decay from induction motors.Apply to low- and medium-voltage, three-phase ac systems.

P. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

Q. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Include in the report identification of any protective device applied outside its capacity.

3.4 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.5 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.

2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

END OF SECTION - 260573.16

SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 This study shall be complete, including all electrical gear, throughout the entire facility.

1.2 DEFINITIONS

A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

D. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

F. SCCR: Short-circuit current rating.

G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

H. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
3. The completed final SKM Project file.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power System Analysis Specialist.

2. For Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.

1.6 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.

E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

G. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. SKM Systems Analysis, Inc.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

   a. Arc-flash boundary.

4. Required minimum arc rating of PPE in Cal/cm squared.
5. Available incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

B. Contractor shall provide recommendations to input values in adjustable circuit breakers. If there are any modifications needed to reduce arc-flash, bring to Owner’s attention. Changes that are no-cost should be implemented unless it hinders operation of equipment connected. Reports to be turned over (printed and software) to the Architect and Owner.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
3. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

G. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

H. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other 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.
2. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Apply one arc-flash label on the front cover and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Low-voltage switchboard.
2. Low-Voltage Switchgear.
3. Medium-voltage switchgear.
4. Medium voltage transformers
5. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
6. Panelboard and safety switch over 250 V.
7. Applicable panelboard and safety switch under 250 V.
8. Control panel.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION - 260573.19

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work under this Section is subject to requirements of the Contract Documents including the Owner's General Conditions and articles of the Construction Manager's General Conditions.

B. General commissioning requirements are detailed in Division 01.

C. The commissioning process does not reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product in accordance with the Contract Documents.

D. This section shall in no way diminish the responsibility of the Division 26 Contractors, Subs and Suppliers in performing all aspects of work and testing as outlined in the contract documents. Any requirements outlined in this section are in addition to requirements outlined in Division 01 and 26 Specifications.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. The requirements in this section are in addition to those specifically outlined in:

C. Section 017900 - Minimum Owner Training Requirements

D. Section 019113 - General Commissioning Requirements

1.3 ELECTRICAL EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

A. The following equipment and systems shall be commissioned as part of this project. All general references to equipment and systems within this document refer only to those identified below:

1. Interior Lighting controls
2. Exterior Lighting Controls
3. Normal Power Distribution (through first level of 480V Distribution Boards)
4. Emergency, Legally Required, and Optional Standby Power Distribution Systems (through first level of 480V Distribution Boards)
5. Electrical Power Monitoring and Control

1.4 REFERENCES

A. Refer to Section 019113 for applicable references for work associated with this section.

1.5 DEFINITIONS & ABBREVIATIONS

A. Refer to Section 019113 for definitions and abbreviations for terms in this section.

1.6 COMMISSIONING TEAM

A. Refer to Section 019113 for commissioning team members.

1.7 COMMISSIONING SUBMITTALS

A. Refer to Section 019113 for additional required commissioning submittals.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Refer to Section 019113 for additional test equipment requirements.

B. If not otherwise specified, the following minimum requirements apply.

1. Voltage measuring equipment (true RMS) shall have a certified accuracy of ±2% of reading with a resolution of 1V.
2. Amperage measuring equipment shall have a certified accuracy of ±2% of reading with a resolution of 0.1A.

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS OVERVIEW

A. Refer to Section 019113 for an overview of the commissioning process.

3.2 ROLES AND RESPONSIBILITIES

A. Refer to Section 019113 for roles and responsibilities of additional team members.

B. Electrical Contractor Responsibilities

1. Include costs for all commissioning requirements in contract price.
2. Provide all necessary certified technicians, tools, meters, and protective equipment to safely and accurately record measurements of energized components.
3. For lighting controls systems, provide factory trained technician who is familiar with the project specific programming to assist with FPTs.
4. For generators, transfer switches, and their controls systems, provide a factory trained technician who is familiar with the project specific programming to assist with FPTs.
5. Review all PFC and FPT test procedures to confirm applicability of requiredinformation.

6. Any tasks indicated within the PFCs and FPT test procedures do not override any other start-up and checkout tasks identified in Division 26. It is the EC's responsibility to ensure the system is fully operational.

3.3 SCHEDULING AND COORDINATION

A. Refer to Section 019113 for scheduling and coordination requirements.

3.4 PRE-FUNCTIONAL CHECKLISTS

A. Refer to Section 019113 for PFC requirements.

B. Execution:

1. The EC shall assist the CxA with documenting PFC information for any energized equipment. EC shall provide appropriate personnel, equipment, and PPE to gather required.

3.5 START-UP AND INITIAL CHECKOUT

A. Refer to Section 019113 for Start-Up and Checkout requirements.

3.6 FUNCTIONAL PERFORMANCE TESTS

A. Refer to Section 019113 for FPT requirements.

B. Execution:

1. The EC shall assist the CxA with documenting PFC information for any energized equipment. EC shall provide appropriate personnel, equipment, and PPE to gather required.

3.7 NON-CONFORMANCE AND COMMISSIONING ISSUES

A. Refer to Section 019113 for information regarding Non-Conformance and Cx Issues.

3.8 OWNER TRAINING

A. The GC/CM is responsible for execution of Owner Training as outlined in section 017900.

3.9 10-MONTH WARRANTY

A. Refer to Section 019113 for 10-Month Warranty requirements.

END OF SECTION

SECTION 260944 - LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single space wireless lighting control systems and associated components:

1. Wireless occupancy/vacancy sensors.
2. Wireless daylight sensors.
3. Wired load control modules with wireless communication inputs.

   a. Includes fixture control modules with wired occupancy/vacancy/daylight sensors.

4. Wired wall dimmers and switches with wireless communication inputs.
5. Wired wallbox occupancy sensors with wireless communication inputs.
6. Wireless control stations.
7. LED Drivers.
8. Power interfaces.

1.2 RELATED REQUIREMENTS

A. The Lighting Control System is a performance based design. The contractor shall submit complete shop drawings for the actual system being provided, including all necessary components for a fully functioning, code compliant system. All items requiring line voltage Normal and Emergency power shall be clearly identified.

B. All lighting control wiring, ethernet, CAT 5, CAT 6, 0-10V etc. shall be enclosed in conduit. No exceptions.

C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 262726 - Wiring Devices

1. Finish requirements for wall controls specified in this section.
2. Accessory receptacles and wallplates, to match lighting controls specified in this section.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; ***current edition***.

B. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements**; *2011***.

C. ANSI/ESD S20.20 - Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)**; *2014***.

D. ASTM D4674 - Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments**; *2002a (Reapproved 2010)***.

E. CAL TITLE 24 P6 – California Code of Regulations, Title 24, Part 6 (California Energy Code)**; *2013***.

F. CSA C22.2 No. 223 – Power Supplies with Extra-low-voltage Class 2 Outputs**; *2015***.

G. IEC 60929 - AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps - Performance Requirements**; *2015***.

H. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test**; *2008***.

I. IEC 61347-2-3 - Lamp Control Gear - Part 2-3: Particular Requirements for A.C. and/or D.C. Supplied Electronic Control Gear for Fluorescent Lamps**; *2011, with Amendments, 2016***.

J. IEEE 1789 - Recommended Practice for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers***; 2015***.

K. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits**; *2002 (Cor 1, 2012)***.

L. ISO 9001 - Quality Management Systems-Requirements**; *2008***.

M. NECA 1 - Standard for Good Workmanship in Electrical Construction**; *2015***.

N. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association**; *2010***.

O. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; National Electrical Manufacturers Association**; *2015***.

P. NEMA SSL 7A – Phase Cut Dimming for Solid State Lighting: Basic Compatibility; National Electrical Manufacturers Association***; 2015***.

Q. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association**; *1999 (R 2015)***.

R. NFPA 70 - National Electrical Code; National Fire Protection Association**; *Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements***.

S. UL 20 - General-Use Snap Switches**; *Current Edition, Including All Revisions***.

T. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc.**; *Current Edition, Including All Revisions***.

U. UL 924 - Emergency Lighting and Power Equipment**; *Current Edition, Including All Revisions***.

V. UL 935 - Fluorescent-Lamp Ballasts**; *Current Edition, Including All Revisions***.

W. UL 1310 – Class 2 Power Units**; *Current Edition, Including All Revisions***.

X. UL 1472 - Solid-State Dimming Controls**; *Current Edition, Including All Revisions***.

Y. UL 1598C - Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits**; *Current Edition, Including All Revisions***.

Z. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces**; *Current Edition, Including All Revisions***.

AA. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products**; *Current Edition, Including All Revisions***.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall controls with actual installed door swings.
3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
4. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting***;*** Lutron LSC-PREWIRE: Include as part of the base bid; for Lighting Control Manufacturer to conduct on-site meeting prior to commencing work. Manufacturer to review with installer:

1. Low voltage wiring requirements.
2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. Wireless hub locations and installation.
5. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "LIGHTING CONTROLS - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
6. Control locations.
7. Load circuit wiring.
8. Installer responsibilities.

C. Sequencing:

1. Do not install sensors and wall controls until final surface finishes are complete.

1.5 SUBMITTALS

A. Design Documents: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "LIGHTING CONTROLS - GENERAL REQUIREMENTS", Lighting Control Manufacturer to provide plans indicating occupancy/vacancy and/or daylight sensor locations.

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy/Vacancy Sensors: Include detailed basic motion detection coverage range diagrams.
2. Wall Dimmers: Include derating information for ganged multiple devices.

C. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. System Performance-Verification Documentation***; Lutron LSC-SPV-DOC***: Include as part of the base bid.

E. Project Record Documents: Record actual installed locations and settings for lighting control system components.

F. Operation and Maintenance Data: Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

G. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.

1. Spare Parts – The contractor shall provide the owner with 10% spare parts for all wireless and wired devices utilized on this project. Where 10% calculates to less than one device, provide a minimum of one device.

H. Warranty: Submit sample of manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under “WARRANTY”. Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications:

1. Company with not less than ten years of experience manufacturing lighting control products using wireless communication between devices.
2. Registered to ISO 9001, including in-house engineering for product design activities.

3. Provides factory direct technical support hotline available 24 hours per day, 7 days per week.
4. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1. Basis of Design System Requirements - Lutron or Leviton, Unless Otherwise Indicated:

a. Ambient Temperature:

1) Lighting Control System Components, Except Fluorescent Electronic Dimming Ballasts: Between 32 and 104 degrees F.
2) Fluorescent Electronic Dimming Ballasts: Between 50 and 140 degrees F.

b. Relative Humidity: Less than 90 percent, non-condensing.
c. Protect lighting controls from dust.

1.9 WARRANTY

A. Manufacturer's Standard Warranty, With Manufacturer Full-Scope Start-Up*;* Lutron or Leviton Standard 2-Year Warranty.

1. Manufacturer Lighting Control System Components :

a. First Two Years:

1) 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a lighting issue.
2) First-available on-site or remote response time.
3) Remote diagnostics for applicable systems.

b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: ***Lutron or Leviton***.

B. Substitutions:

1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by Architect a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis and Complete shop drawings specific to the facility with all devices incorporated on .pdf drawings.
2. By using pre-approved substitutions, Contractor accepts responsibility and associated costs for all required modifications to related equipment and wiring. Provide complete engineered shop drawings (including power wiring) with deviations from the original design highlighted in an alternate color for review and approval by Architect prior to rough-in.

C. Source Limitations: Furnish products produced by Lutron or Leviton manufacturer and obtained from a single supplier.

2.2 LIGHTING CONTROLS - GENERAL REQUIREMENTS

A. Sensor Layout and Tuning: Include as part of the base bid:

1. Lighting Control Manufacturer to take full responsibility for wired or wireless occupancy/vacancy and daylight sensor layout and performance for sensors provided by Lighting Control Manufacturer.
2. Lighting Control Manufacturer to analyze the reflected ceiling plans, via supplied electronic AutoCAD format, and design a detailed sensor layout that provides adequate occupancy sensor coverage and ensures occupancy and daylight sensor performance per agreed upon sequence of operations. Contractor to utilize the layouts for sensor placement.
3. During startup, Lighting Control Manufacturer to direct Contractor regarding sensor relocation, as required, should conditions require a deviation from locations specified in the drawings.
4. Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits, within one calendar year from Date of Substantial Completion to fine-tune sensor calibration per the agreed upon sequence of operations.

B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, programming, etc. as necessary for a complete operating system that provides the control intent indicated.

D. Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F to 104 degrees F and 90 percent non-condensing relative humidity.

E. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

F. Power Failure Recovery: When power is interrupted for periods up to 10 years; and subsequently restored, lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.

G. Wireless Devices:

1. Wireless device family includes area or fixture level sensors, area or fixture level load controls for dimming or switching, and load controls that can be mounted in a wallbox, on a junction box, or at the fixture.
2. Wireless devices including sensors, load controls, and wireless remotes or wall stations, can be set up using simple button press programming without needing any other equipment (e.g. central hub, processor, computer, or other smart device).
3. System does not require a factory technician to set up or program the system.
4. Capable of diagnosing system communications.
5. Receives signals from other wireless devices and provides feedback to user.
6. Capable of determining which devices have been addressed.
7. RF Range: 60 feet line-of-sight or 30 feet through typical construction materials between RF transmitting devices and compatible RF receiving devices.
8. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.

2.3 WIRELESS SENSORS

A. General Requirements:

1. Operational life of 10 years without the need to replace batteries when installed per manufacturer's instructions.
2. Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
3. Does not require external power packs, power wiring, or communication wiring.
4. Capable of being placed in test mode to verify correct operation from the face of the unit.

B. Wireless Occupancy/Vacancy Sensors:

1. General Requirements:

a. Provides a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
b. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.

c. Sensing Mechanism: Passive infrared coupled with technology for sensing fine motions***;*** Lutron or Leviton . Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
d. Provide optional, readily accessible, user-adjustable controls for timeout, automatic/manual-on, and sensitivity.
e. Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
f. Capable of turning dimmer's lighting load on to an optional locked preset level selectable by the user. Locked preset range to be selectable on the dimmer from 1 percent to 100 percent.
g. Color: White.
h. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
i. Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.
j. Sensor lens to illuminate during test mode when motion is detected to allow installer to place sensor in ideal location and to verify coverage prior to permanent mounting.
k. Ceiling-Mounted Sensors:

1) Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
2) Provide recessed mounting bracket compatible with drywall and compressed fiber ceilings.

l. Wall-Mounted Sensors: Provide wall or corner mounting brackets compatible with drywall and plaster walls.

2. Wireless Combination Occupancy/Vacancy Sensors:

a. Ceiling-Mounted Sensors: Programmable to operate as an occupancy sensor (automatic-on and automatic-off), an occupancy sensor with low light feature (automatic-on when less than one footcandle of ambient light available and automatic-off), or a vacancy sensor (manual-on and automatic-off).
b. Wall-Mounted Sensors: Programmable to operate as an occupancy sensor (automatic-on and automatic-off), or a vacancy sensor (manual-on and automatic-off).
c. Product(s):

1) Ceiling-Mounted Occupancy/Vacancy Sensor; Lutron Radio Powr Savr Series or Leviton Equal, Model LFR2-OCR2B-P-WH; or Lutron Radio Powr Savr Series, Model ULFR2-OCR2B-P-WH Coverage from 324 square feet to 676 square feet depending on ceiling height from 8 to 12 feet; 360 degree field of view.

2) Wall-Mounted Occupancy/Vacancy Sensor***; Lutron Radio Powr Savr Series or Leviton Equal, Model LFR2-OWLB-P-WH; or Lutron Radio Powr Savr Series, Model ULFR2-OWLB-P-WH*** Minor motion coverage of 1500 square feet and major motion coverage of 3000 square feet with mounting height of 6 to 8 feet; 180 degree field of view.
3) Corner-Mounted Occupancy/Vacancy Sensor***; Lutron Radio Powr Savr Series or Leviton Equal, Model LFR2-OKLB-P-WH; or Lutron Radio Powr Savr Series, Model ULFR2-OKLB-P-WH*** Minor motion coverage of 1225 square feet and major motion coverage of 2500 square feet with mounting height of 6 to 8 feet; 90 degree field of view.
4) Hallway Occupancy/Vacancy Sensor***; Lutron Radio Powr Savr Series or Leviton Equal, Model LFR2-OHLB-P-WH; or Lutron Radio Powr Savr Series, Model ULFR2-OHLB-P-WH*** Major motion coverage of up to 150 feet with mounting height of 6 to 8 feet; narrow field of view.

3. Wireless Vacancy-Only Sensors:

a. Product(s):

1) Ceiling-Mounted Vacancy-Only Sensor***; Lutron Radio Powr Savr Series, Model LFR2-VCR2B-P-WH; or Lutron Radio Powr Savr Series*** or Leviton Equal***, Model ULFR2-VCR2B-P-WH*** Coverage from 324 square feet to 676 square feet depending on ceiling height from 8 to 12 feet; 360 degree field of view.
2) Wall-Mounted Vacancy-Only Sensor***; Lutron Radio Powr Savr Series*** or Leviton Equal***, Model LFR2-VWLB-P-WH; or Lutron Radio Powr Savr Series, Model ULFR2-VWLB-P-WH*** Minor motion coverage of 1500 square feet and major motion coverage of 3000 square feet with mounting height of 6 to 8 feet; 180 degree field of view.
3) Corner-Mounted Vacancy-Only Sensor***; Lutron Radio Powr Savr Series*** or Leviton Equal***, Model LFR2-VKLB-P-WH; or Lutron Radio Powr Savr Series, Model ULFR2-VKLB-P-WH*** Minor motion coverage of 1225 square feet and major motion coverage of 2500 square feet with mounting height of 6 to 8 feet; 90 degree field of view.
4) Hallway Vacancy-Only Sensor***; Lutron Radio Powr Savr Series*** or Leviton Equal***, Model LFR2-VHLB-P-WH; or Lutron Radio Powr Savr Series, Model ULFR2-VHLB-P-WH*** Major motion coverage of up to 150 feet with mounting height of 6 to 8 feet; narrow field of view.

C. Wireless Daylight Sensors:

1. Product: ***Lutron Radio Powr Savr Series*** or Leviton Equal***, Model LFR2-DCRB-WH***.
2. Open-loop basis for daylight sensor control scheme.
3. Stable output over temperature from 32 degrees F to 104 degrees F.
4. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
5. Provide linear response from 2 to 150 footcandles.
6. Color: White.
7. Mounting:

a. Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
b. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
c. Provide temporary mounting means for drop ceilings to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.

2.4 LOAD CONTROL MODULES

A. Provide wireless load control modules as indicated or as required to control the loads as indicated.

B. Junction Box-Mounted Modules:

1. Plenum rated.
2. 0-10 V Dimming Modules:

a. Product(s):

1) 8 A dimming module with 0-10V control, without emergency mode***;*** **Lutron PowPak Dimming Module Model RMJS-8T-DV-B; or Lutron PowPak Dimming Module Model URMJS-8T-DV-B** or Leviton Equal.
2) 8 A dimming module with 0-10V control, with emergency mode***;*** **Lutron PowPak Dimming Module Model RMJS-8T-DV-B-EM** or Leviton Equal.

b. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
c. Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.
d. Selectable minimum light level.
e. Configurable high- and low-end trim.
f. Relay: Rated for 0-10 V ballasts, LED drivers, or fixtures that conform with NEMA 410.

3. Relay Modules:

a. Product(s):

1) 16 A relay module, without emergency mode, without contact closure output***;*** **Lutron PowPak Relay Module Model RMJS-16R-DV-B; or Lutron PowPak Relay Module Model URMJS-16R-DV-B** or Leviton Equal.
2) 16 A relay module, with emergency mode, without contact closure output***;*** **Lutron PowPak Relay Module Model RMJS-16R-DV-B-EM** or Leviton Equal.

3) 16 A relay module, without emergency mode, with contact closure output***;*** **Lutron PowPak Relay Module Model RMJS-16RCCO1-DV-B; or Lutron PowPak Relay Module Model URMJS-16RCCO1-DV-B** or Leviton Equal.
4) 5 A relay module, without emergency mode, without contact closure output***;*** ***Lutron PowPak Relay Module Model RMJS-5R-DV-B*** or Leviton Equal.
5) 5 A relay module, without emergency mode, with contact closure output***;*** ***Lutron PowPak Relay Module Model RMJS-5RCCO1-DV-B*** or Leviton Equal.

b. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
c. Relay:

1) Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
2) Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
3) Fully rated output continuous duty for inductive, capacitive, and resistive loads.

d. Contact Closure Output:

1) Single contact closure output with normally open and normally closed dry maintained contacts suitable for connection to third party equipment (e.g. building management system, HVAC system, etc.).
2) Contact Ratings: Resistive load; 1 A at 0-24 VDC, 0.5 A at 0-24 VAC.

e. Relay Modules With Emergency Mode:

1) Operation Without ***Lutron Vive*** Wireless Hub: Upon loss of power, relay module enters and remains in emergency mode for 90 minutes, during which time local unit buttons and wireless controls are disabled.

4. Contact Closure Output Modules:

a. Product: **Lutron PowPak CCO Module Model RMJS-CCO1-24-B; or Lutron PowPak CCO Module Model URMJS-CCO1-24-B** or Leviton Equal.
b. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
c. Contact Closure Output:

1) Single contact closure output with normally open and normally closed dry maintained contacts suitable for connection to third party equipment (e.g. building management system, HVAC system, etc.).
2) Contact Ratings: Resistive load; 1 A at 0-24 VDC, 0.5 A at 0-24 VAC.
3) Operation affected by associated occupancy/vacancy sensors and wall controls.

2.5 WIRED WALL DIMMERS AND SWITCHES WITH WIRELESS COMMUNICATION INPUTS

A. General Requirements:

1. Provide air gap service switch to disconnect power to load for safe lamp replacement, accessible without removing faceplate.
2. Operates at the rated capacity across the full ambient temperature range including modified capacities for ganged configurations which require removal of fins.
3. Provide radio frequency interference suppression.
4. Surge Tolerance: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
5. Dimmers: Provide full range, continuously variable control of light intensity.
6. Dimmers for Electronic Low Voltage (ELV) Transformers:

   a. Provide circuitry designed to control the input of electronic (solid-state) low voltage (ELV) transformers. Do not use dimmers that utilize standard phase control.
   b. Provide resettable overload protection that provides automatic shut-off when dimmer capacity is exceeded. Do not use protection methods that are non-resettable or require device to be removed from outlet box.
   c. Designed to withstand a short, per UL 1472, between load hot and either neutral or ground without damage to dimmer.

7. Electronic Switches:

   a. Listed as complying with UL 20, UL 508, and UL 1472.

B. Preset Smart Wall Dimmers and Switches with Wireless Communication Inputs***; Lutron Maestro Wireless Series*** or Leviton Equal*:*

2.6 WIRED WALLBOX OCCUPANCY SENSORS WITH WIRELESS COMMUNICATION INPUTS

A. 0-10 V Wall Dimmer/Switch Combination Occupancy/Vacancy Sensors with Wireless Communication Inputs***; Lutron Maestro Wireless 0-10 Dimmer Sensor/Maestro Wireless Sensor Switch Series*** or Leviton Equal:

1. Communicates via radio frequency with up to ten compatible wireless occupancy/vacancy sensors, ten wireless control stations, and one wireless daylight sensor.
2. Compatible with sourcing electronic 0-10 V ballasts/drivers, as per IEC 60929 Annex E.2 0-10 V protocol.
3. Selectable option to enable low light feature (automatic-on when ambient light is below threshold). Ambient light threshold to be selectable as either adaptive utilizing occupant feedback **(Lutron Smart Ambient Light Detection)** or as fixed (high, medium, low, and minimum presets).
4. Occupancy/Vacancy Sensors:

a. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
b. Sensing Mechanism: Passive infrared coupled with technology for sensing fine motions***; Lutron XCT Technology*** or Leviton Equal. Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
c. Programmable to operate as an occupancy sensor (automatic-on and automatic-off) or a vacancy sensor (manual-on and automatic-off).
d. Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area; adjustable timeout settings (1, 5, 15, or 30 minutes).
e. Adjustable sensitivity (high, medium, low, and minimum presets).
f. Selectable option to inhibit automatic turn-on of lights after manual-off operation while room is occupied for applications such as presentation viewing in conference rooms and classrooms; when room is vacated, returns to normal automatic-on operation after time delay period.
g. Selectable walk-through mode to override selected timeout and automatically turn off lights if no motion is detected within 3 minutes after initial occupancy for applications where space may be briefly occupied.

5. Dimmer Features:

a. Adjustable high/low end trims.
b. Selectable dimming curve (linear or switched).
c. Selectable fade on/fade off times (15, 5, 2.5, or 0.75 sec).
d. Adjustable auto-on light level (fully adjustable from one to 100 percent).

6. Dimmer Control: Multi-function tap switch with small, raised rocker for dimmer adjustment.

a. Rocker raises/lowers light level, with new level becoming the current preset level.
b. Switch single tap raises lights to preset level or fades lights to off.
c. Switch double tap raises light to full on level.

7. Switch Control: Switch single tap turns lights on/off.
8. Product(s):

a. Passive Infrared 0-10 V Wall Dimmer Occupancy/Vacancy Sensor***; Lutron Maestro Wireless 0-10 V Dimmer Sensor/Maestro Wireless Sensor Switch Series*** or Leviton Equal: 0-10 V control for 0-10 V fluorescent ballasts/LED drivers (8 A load at 120-277 V, 50 mA max control current); coverage of 900 square feet with mounting height of 4 feet; 180 degree field of view; multi-location capability using ***Pico*** wireless control stations with wallbox mounting adapter.

1) Sensor dimmer; occupancy/vacancy; ***Lutron Model MRF2S-8SD010*** or Leviton Equal.
2) Sensor dimmer; vacancy-only; ***Lutron Model MRF2S-8SDV010*** or Leviton Equal.
3) Sensor switch; occupancy/vacancy; ***Lutron Model MRF2S-8SS*** or Leviton Equal.

4) Sensor switch; vacancy-only; ***Lutron Model MRF2S-8SSV*** or Leviton Equal.

2.7 WIRELESS CONTROL STATIONS

A. Product(s):

1. 2-Button Control; **Lutron Pico Wireless Control Model PJ2-2B; or Lutron Pico Wireless Control Module UPJ2-2B** or Leviton Equal.
2. 2-Button Control with Night Light***; Lutron Pico Wireless Control Model PJN-2B*** or Leviton Equal.
3. 2-Button with Raise/Lower Control; **Lutron Pico Wireless Control Model PJ2-2BRL; or Lutron Pico Wireless Control Module UPJ2-2BRL** or Leviton Equal.
4. 3-Button Control; **Lutron Pico Wireless Control Model PJ2-3B; or Lutron Pico Wireless Control Module UPJ2-3B** or Leviton Equal.
5. 3-Button with Raise/Lower Control; **Lutron Pico Wireless Control Model PJ2-3BRL; or Lutron Pico Wireless Control Module UPJ2-3BRL** or Leviton Equal.
6. 3-Button with Raise/Lower Control and Night Light***; Lutron Pico Wireless Control Model PJN-3BRL*** or Leviton Equal.
7. 4-Button; **Lutron Pico Wireless Control Model PJ2-4B; or Lutron Pico Wireless Control Module UPJ2-4B** or Leviton Equal.
8. Single Pedestal***; Lutron Pico Pedestal Model L-PED1*** or Leviton Equal.
9. Double Pedestal***; Lutron Pico Pedestal Model L-PED2*** or Leviton Equal.
10. Triple Pedestal***; Lutron Pico Pedestal Model L-PED3*** or Leviton Equal.
11. Quadruple Pedestal***; Lutron Pico Pedestal Model L-PED4*** or Leviton Equal.
12. Screw Mounting Kit***; Lutron Model PICO-SM-KIT*** or Leviton Equal.
13. Wallbox Adapter***; Lutron Model PICO-WBX-ADAPT*** or Leviton Equal.

B. Quantity: As indicated on the drawings; provide allowance for 0 to 10 additional control stations.

C. Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.

D. Does not require external power packs, power or communication wiring.

E. Allows for easy reprogramming without replacing unit.

F. Button Programming:

1. Single action.
2. Toggle action.

G. Includes LED to indicate button press or programming mode status.

H. Mounting:

1. Capable of being mounted with a table stand or directly to a wall under a faceplate.
2. Faceplates: Provide concealed mounting hardware.

I. Power: Battery-operated with minimum ten-year battery life (3-year battery life for night light models).

J. Finish: To be selected by Architect.

2.8 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory Testing***; Lutron OR Leviton Standard Factory Testing***:

1. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install products in accordance with manufacturer's instructions.

C. Sensor Locations:

1. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "LIGHTING CONTROLS - GENERAL REQUIREMENTS", locate sensors in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, locate sensors in accordance with Drawings.
2. 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.

D. Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaires.

E. LED Light Engine/Array Lead Length: Do not exceed 100 feet.

F. Identify system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Full-Scope Start-Up Service is required**.**

B. Manufacturer’s Programming Service:

1. Product(s):

C. Manufacturer's Full-Scope Start-Up Service: **Provide manufacturer's On-Site Full-Scope Start-Up Service**.

1. On-Site Full-Scope Start-Up Service***; Lutron LSC-OS-SU-VIVE***: Manufacturer's authorized Service Representative to conduct site visit upon completion of lighting control system installation to perform system startup and verify proper operation:

a. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "LIGHTING CONTROLS - GENERAL REQUIREMENTS", authorized Service Representative to verify sensor locations, in accordance with layout provided by Lighting Control Manufacturer; Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
b. Verify connection of power wiring and load circuits.
c. Verify connection and location of controls.
d. Associate occupancy/vacancy sensors, daylight sensors, wireless remotes, and wall stations to load control devices.
e. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by Lighting Control Manufacturer as part of Sensor Layout and Tuning service where specified in Part 2 under "LIGHTING CONTROLS - GENERAL REQUIREMENTS".
f. Verify system operation control by control.
g. Obtain sign-off on system functions.
h. Train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".

D. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.4 ADJUSTING

A. Sensor Fine-Tuning: Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "LIGHTING CONTROLS - GENERAL REQUIREMENTS", Lighting Control Manufacturer to provide up to two additional post-startup on-site service visits for fine-tuning of sensor calibration. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, Contractor to provide fine-tuning of sensor calibration.

3.5 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration:

1. Demonstrate proper operation of lighting control devices to Owners Representative, and correct deficiencies or make adjustments as directed.
2. On-Site Performance-Verification Walkthrough; Lutron LSC-WALK or Leviton Equal: Include **as part of the base bid** additional costs for lighting control manufacturer to provide on-site demonstration of system functionality to **facility representative**.

B. Training:

1. Include services of manufacturer's certified service representative to perform on-site training of Owner's personnel on operation, adjustment, and maintenance of lighting control system as part of on-site system start-up services.

3.7 MAINTENANCE

A. System Optimization Visit***; Lutron LSC-SYSOPT-SP***: Include additional costs for Lighting Control System Manufacturer to visit site **six months** after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

3.8 PROTECTION

A. Protect installed products from subsequent construction operations.

END OF SECTION

SECTION 260951 - CENTRAL INVERTER FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Central Battery Inverter.

1.2 RELATED DOCUMENTS

A. This specification shall provide all electrical, technical and mechanical data relevant to the E3MAC Single-Phase Centralized Inverter system. The inverter shall supply Pure Sine Wave emergency power equivalent in quality to utility grade power. A high crest factor with substantial overload protection allows this inverter to drive difficult loads reliably.

B. Standards

   1. UL 924
   2. UL 65 KAIC tested per UL 61800-5-1
   3. NFPA 101 Life Safety Code
   4. NFPA 70 National Electrical Code
   5. ICC-ES AC 156 (Seismic Certification)
   6. IBC/CBC 2016
   7. ANSI C62.41: ANSI C62.45 (Category A & B)
   8. OSHA
   9. OSHPD Preapproval of Manufacturer's Certification (OPM)

1.3 FIELD CONDITIONS

A. RECOMMENDED LOCATION:

   1. The manufacturer recommends that all Inverter Cabinets reside in a dry, conditioned Space with normal ventilation. Relative Humidity shall be <95% non-condensing. All Cabinets are designed for NEMA Type-1 compliance.

B. OPERATING TEMPERATURE:

   1. Normal operating temperature is defined as between 68°F (20°C) to 86°F (30° C) Ambient temperatures above 77°F (25°C) will reduce the service life of the batteries.

C. STORAGE TEMPERATURE:

1. Storage before installation is critical for battery life expectancy and warranty. Batteries should be stored indoors in a clean, dry, and cool location. Storage at higher temperatures will result in accelerated rates of self-discharge and possible deterioration of battery performance and life. The recommended storage schedule based on temperature is as follows:

    a. 32°F (0°C) to 50°F (10°C) 9 Months
    b. 51°F (11°C) to 77°F (25°C) 6 Months
    c. 78°F (26°C) to 92°F (33°C) 3 Months

D. ELEVATION:

1. No derating required up to 1,600 Meters (5,280 ft.).
2. Apply derating of 2% per 125M up to maximum of 2,500 Meters (8,250 ft.) Consult factory for elevations greater than 2,500 Meters (8,250ft)

1.4 WARRANTY

A. Electronics Warranty

1. Refer to the standard Central Power Systems Warranty policy, which is available for download on the manufacturer's website. All information within the Central Power Systems Warranty supersedes this document.

B. Extended Manufacturer Warranty

1. The extended manufacturer's electronics warranty shall be for a period of 5 full years, if options Extended Warranty (EW) and Startup Commissioning (FS) are included.
2. Refer to the standard Central Power Systems Warranty policy, which is available for download on the manufacturer's website. All information within the Central Power Systems Warranty supersedes this document.

C. VRLA Batteries

1. The manufacturer's warranty on VRLA batteries follows the following warranty schedule:
    a. Repair or Replacement without charge - 1 year
    b. Pro-Rated Charge Repair or Replacement - 9 years

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The Central Inverter referenced within this specification document shall be the E3MAC Modular Inverter manufactured by Isolite Corporation in Trevose, PA. Substitutions:

1. Proposed substitutions (clearly delineated as such) must be submitted in writing for approval by Architect a minimum of 10 working days prior to bid date and must be made available to all bidders. Proposed substitutes must be accompanied by review of specification noting compliance on line-by-line basis.

B. Manufacturer Quality Assurance:

1. Manufacturer shall be registered to the ISO 9001:2015 quality standards.

2.2 REQUIREMENTS

A. Furnish and install an Isolite E3MAC Modular Single-Phase Inverter that meets the following requirements for a minimum time period of 90 minutes:

1. Input Voltage 277 VAC
2. Output Voltage 277VAC
3. Rating kW/kVA as shown on inverter schedule

2.3 INPUT SPECIFICATIONS

Phase Configuration	Split Phase (3-wire plus ground)
Input Voltage	277V
Operating Range	± 10% Nominal Utility Voltage
Frequency Range	Hz ± 3 Hz
Power Factor	Lag/0.5 Lead [1]
Current Limit	125%
Efficiency	98%
Surge Protection	Compliant and tested per UL 924
Brown-Out Protection	87.5% of Nominal Utility Voltage
Short Circuit Withstand	65 KAIC

2.4 OUTPUT SPECIFICATIONS

Output Voltage	277V as specified
Crest Factor	≥ 4.0
Overload Capability	120% for 10 minutes, 400% for 500mS
Load Power Factor	2.5 Lag/0.5 Lead [2]
Power Factor Rating	KW = KVA [2]
Harmonic Distortion	≤ 3%
Frequency Range	60Hz +/- 0.02 Hz crystal controlled during emergency mode
Transfer Time	Less than 2mS (fast transfer)

ConfigurationOutput Configuration	Configured for Normally On operation (See Section 6.0 for Normally Off or Switched options)

2.6 BATTERY

Run Time	90 Minutes
Type	VRLA Maintenance-Free Lead Calcium
Charging	Three Rate Charger circuit fully temperature compensated
Recharge Time	≤ 24 hours
Buss Voltage	48VDC through 144VDC (model dependent) 2.27V Float Voltage per cell 1.67-1.70 Low Voltage Disconnect per cell
Battery Warranty	1 year full, 9 years pro-rata
Fire Safety	Flame Retardant UL 94V-0
Design	Front Terminal (ease of access)
Battery Approval	IEC 60896-21 and 60896-22 Certified UL Certified

A. Input Power factor is heavily influenced from pass-through of connected load

B. The inverter can support wide power factor variations (0.5 Lag/0.5 Lead); however, the unity Power Factor Rating (KW=KVA) specifies the maximum output limits that cannot be exceeded.

1. Design
   a. Modular Design - The inverter construction shall use a modular technique so that sizes shall be available in increments from 1.0 to 12.5 kVA capacities. Modules shall be interconnected to build the required system capacity and shall be field-upgradable to increase system size. Inverter modules shall be high frequency Pulse Width Modulated (PWM) using isolation transformers and IGBT or MOSFET switching schemes which allow for high quality pure sine wave and multi- voltage capabilities.
   b. Convection Cooling - Thermal design performance shall achieve 100% reliance on natural convection during the standby or "Normal Operation" mode (99.9% of product life). Fans shall only be operational during "Emergency Operation" mode and bulk re-charging of the batteries. This increases efficiency, improves reliability, and eliminates the need for air filters and routine dust-removal maintenance commonly found with units employing continuous operation fans.
   c. Front Access - All inverters shall utilize a front-facing access door on both the inverter cabinet and battery cabinet. The All inverters shall utilize a front-facing access door on both the inverter cabinet and battery cabinet. The batteries utilized in these units have front facing terminals. This design allows for easy access for troubleshooting and battery installation from the front face with no side access required.
   d. DC Isolation from AC - Batteries shall have isolation from the incoming or outgoing AC line voltage and Earth Ground. This feature allows a direct short between any battery-to-chassis ground without damage. Minimum impedance to chassis ground shall be 100 kOhms.

e. Short Circuit Withstand Capability - The Inverter's internal AC distribution shall be capable of a short circuit withstand of 65,000 Ampere Interrupting Capacity (65 KAIC). The inverter shall be tested and listed in compliance with the IEC testing standards UL 61800-5-1 and shall also include this rating when using optional output circuit breakers which are UL 489 rated.
f. Inverter Compliance - The inverter shall be tested and listed by Underwriters Laboratory to the UL 924 standard which also includes the Self-testing and Self-Diagnostic portion of the standard. Self-Testing shall be performed monthly for a minimum of 30 seconds and annually for a minimum of 90 minutes to comply and also contain fully programmable, password protected Load-Reduction fault programming capabilities.
g. User Interface/Alarms - The inverter shall include an intuitive four-line, 20 character LED-backlit display and five button keypad user interface referred to as the Man-Machine Interface (MMI). This interface shall allow the user to scroll through all meters, alarms, test logs and programming functions via the keypad and display. An SD Memory Slot and Mini-USB connection shall also allow for easy offloading of events/records.

C. MMI FEATURES

1. The following features are standard on all modular inverters.

2. Password Protected
   a. All user configurable system features exist in a Password Protected menu within the unit.

3. One-Button System Test
   a. UL 924 compliance is easily achievable by the press of one button on the front panel of the inverter. A 30 second test will initiate self-testing and self-diagnostics by analyzing battery voltages and output loads.

4. Scheduled Testing
   a. The inverter can be programmed to automatically perform monthly and annual 90-minute NFPA compliance tests. User can specify minute, hour, day and month.

D. METERING FUNCTIONS

1. The MMI shall allow the user to monitor the following meter functions via the LCD screen:
   a. Input Voltage (L-N)
   b. Output Voltage (L-N)
   c. Output Current
   d. Output VA
   e. Battery Voltage
   f. Battery Current
   g. Battery Power
   h. Temperature
   i. System Days
   j. Inverter Minutes
   k. Inverter Events

2.7 ALARMS

A. The active alarms shall be displayed in the Alarm Menu when alarms are present. All alarms shall signal the user with both an Audible Alarm and a Visual Alarm LED on the unit's front panel.

1. Startup Mode Alarms
Communication, Setup Conflict, Battery Voltage, Back- Feed, Transfer /AC Fuse, Overload, Mis-Wire, Incorrect AC (Fixed Alarms, Not Configurable)

2. Charger Mode Alarms
Communication, Over-Temperature, DC Fuse, No Charge, Overcharge, Back-Feed, AC Fuse/Wiring, Program Reference (Fixed Alarms, Not Configurable)

3. User Programmable Alarms
Low Battery, Near Low Battery, High Temperature, Utility Failure, Low VAC, High VAC, Load Reduction. (Password Protected, Configurable)

B. Onboard Event/Test/Alarm Logging

1. Event Logs, Test Logs and Alarm Logs shall be stored on board the inverter's MMI. The system shall store up to 1000 of each type in a First in - First out process. All data can be downloaded via local SD, local USB, and the Remote Web Monitoring system.

2. Event Log - During an Event, the system shall keep a record of each critical parameter Including: Start/End Time, Date of the event, Start/End Output Voltage (Phase A, B, and C), Start/End Output Current (Phase A, B, and C), Start/End Output VA (Phase A, B, and C), Start/End Battery Voltage, Battery Current, Start/End Temperature

3. Test Log - Identical to the Event Log with the exception that the Test Log is only stored when a system test is either: User Initiated by pressing the Test Button on the front panel keypad or via the "Test Button" on the Remote Web Monitoring system control panel OR When the system is instructed by the programmable automatic monthly or yearly test

4. Alarm Log - In the event an alarm occurs from any of the sources detailed in Section 2.8, the alarm is immediately stored into memory.

C. User Setup Menu:

1. The password protected User Menu shall allow adjustments to the following parameters:
   a. Date (MM,DD,YY)
   b. Time (24hr)
   c. Month Test
   d. Year Test
   e. Low VAC Alarm
   f. High VAC Alarm
   g. Near Low Battery Alarm
   h. Utility Failure Alarm
   i. High Temperature Alarm
   j. Time Delay
   k. Load Reduction Alarm

l. Alarm Relay(s)
m. Backup Logs
n. Contact Name
o. Contact Phone Number

2.8 QUALITY ASSURANCE

A. Manufacturer Testing

1. All inverters shall be manufactured in Trevose, PA. End-of-line quality tests shall be performed by the build team. Each unit produced shall be 100% load tested and run through a series of durability tests, fault tests and unit-specific option tests by the Quality Control Team. The inverter shall then be inspected a third time to ensure 100% specification compliance prior to shipping.

B. SELF TESTING

1. Each inverter shall utilize several different methods of self-testing. On start-up, each unit shall test the following prior to entering Normal Operation Mode: Communications, Set-Up Conflict, Low Battery, Back-feed, Transfer/AC Fuse, Short/Overload, Miswire, and Incorrect AC Input. Scheduled Self-Tests can be programmed into the unit for Monthly tests and Yearly 90-minute NFPA compliance tests. In addition, each unit shall continuously test itself and notify users of issues via the Onboard Diagnostics and the LifeGuard Online Remote Monitoring.

2.9 FABRICATION

A. Cabinet Construction

1. The inverter cabinets shall be made from 14 gauge cold-rolled steel. All corners and seams shall be welded and ground smooth before powder coating. Internally, each inverter module and shelf shall have galvanized or painted steel parts to resist corrosion and provide high durability. There is no visible hardware on the outside of the cabinet, with all components contained within the enclosure. Each cabinet design shall have multiple pre- punched Electrical Knock Outs (EKO) on the top and sides for quick and clean conduit installation by a qualified electrician. Seismic Certified Brackets shall be available as an option (see Section 7.0 "Options"). All Cabinets are designed for NEMA Type-1 compliance.

B. Cabinet Finish

1. Each inverter cabinet is powder coated with 2-tone TIGER Drylac®. Cabinet: TIGER Drylac® Texture Matte Finish Powder Coat - 09/71420 RAL 7016 (GREY) Door: TIGER Drylac® Texture Smooth Finish Powder Coat - 49/73510 RAL 7035 (LT GREY)

C. Manufacturing Method/Location

1. Each inverter shall be designed, developed, and manufactured in Trevose, PA. Each unit shall be built to order and therefore fully custom. Each unit shall be 100% tested for an extended period of time before being released to be shipped.

2.10 Trip Alarm (option code - TA)

A. When Trip Alarm Breakers are purchased, the inverter shall monitor each of those outputs for tripping. If any of the breakers trip, the unit will broadcast an alarm.

2.11 Terminal Block (option code - TB)

A. 1 Summary / 2 Programmable terminal blocks. Allows inverter operations to be output to a BMS System via a Form C dry contact closure. The programmable terminal block can be field or factory configured for the following:

1. AC Present
2. Battery Charging
3. High-Temperature Alarm
4. Utility Failure Alarm
5. Near Low Battery Alarm
6. Low Battery Alarm
7. High VAC Alarm
8. Low VAC Alarm

2.12 Keyed Lock (option code - KE)

A. This option shall add a lock and key to the cabinet to prevent unauthorized entry.

2.13 Extended Electronics Warranty (option code - EEW)

A. Extended Electronics Warranty can be purchased if the Factory Startup (FS) option has been purchased with the unit. The extended warranty period shall be for 5 years. For more information, please see "Section 9.0 Warranty".

2.14 Factory Startup (option code - FS)

A. Factory Startup shall include a visit from a factory-certified technician for inverter activation and demonstration. This option automatically extends the factory warranty from 2 years to 3 years.

2.15 Wall Mount (option code - WB)

A. A wall-mount option is available for the 1kVA unit only.

2.16 BMS Integration (option code - BI)

A. This option allows for the integration of BACNet/MSTP, BACNet/IP, ModBus, and ModBus/RTU systems with the E3MAC inverter system. Alarms and real-time information generated from the E3MAC system are propagated to the BMS system.

2.17 The standard output configuration on all inverters shall be Normally On. Breakers can be added to any output type. Breakers shall be a UL 489 type approved for field wiring and maintain a 65KAIC rating. (See ordering guide for available breaker and trip alarm configurations)

A. Normally On Output

B. Shall be energized 24/7 in all modes.

2.18 Normally Off Output

A. Shall only be energized in Emergency Operation Mode.

2.19 Switched Output

A. Shall be energized/de-energized with a switched command signal. In Emergency Operation Mode the load shall be energized regardless of the switch command signal.

2.20 NORMAL OPERATION (PASS-THROUGH MODE)

A. When normal utility power is present, the inverter shall run in Pass-Through Mode. Utility Power will be the source of power for all circuits, simply passing through the inverter unit to supply those circuits. The inverter unit will consume a small amount of power to run internal monitoring circuits and provide float charging to the battery circuit.

2.21 EMERGENCY OPERATION (DISCHARGING MODE)

A. When a loss of utility power occurs on any phase, the inverter shall detect this and switch to Discharging Mode. The inverter shall transfer to supplying AC to the connected circuits in less than 2 mS. Once utility power is restored, the inverter shall switch back to using utility power to supply the connected circuits.

2.22 RECHARGE OPERATION (CHARGING MODE)

A. The inverter shall revert to Charging Mode when utility power is returned to the unit. If batteries are fully depleted, they shall be fully recharged within 24 hours. The Three Rate Charger circuit is fully temperature-compensated for added reliability.

PART 3 - EXECUTION

3.1 Factory Start-up (Onsite Commissioning)

A. Factory Start-up shall be an available option on all inverters (option FS, see section 7.10). Using the manufacturer's Field Service to start-up the unit will ensure proper installation, system longevity, and extend the standard electronics warranty from 2 years to 3 years. Factory Startup shall include, but is not limited to the following:

1. Perform visual inspection of all input and output connections made by electrician
2. Inspect all bolts and battery buss bars for proper torque specification
3. Setup and configure all settings, alerts and alarms per specification
4. Calibrate the inverter
5. Run diagnostic tests and alert/alarm tests
6. Record all current settings on inverter to set a baseline for future servicing
7. Perform training for user or point of contact when present
8. Setup Remote Web Monitoring system per specification
9. Test all modes of operation: Normal Mode, Emergency Mode, and Charging Mode

B. Contractor shall connect diagnostic alarm contact closures to the nearest MetaSys panel and integrate in the CCMS for remote monitoring of an alarm condition.

3.2 SITE REQUIREMENTS

A. The following Site Requirements are imperative to proper system installation.

B. Battery Chemistry

1. The inverter shall be supplied with Valve Regulated Lead Acid (VRLA) batteries standard. These VRLA Batteries shall use Absorbent Glass Material (AGM) as the separator and utilize Recombinant Technology, which helps minimize gas emissions. The electrolyte used in the VRLA batteries shall not exceed 50 gallons in total, which is compliant with current IFC/UFC codes.

C. Ventilation

1. As previously stated in section "2.6.2 Convection Cooling", each inverter shall be cooled by natural convection. For VLRA battery systems, the ventilation requirements for human occupancy and electronic equipment will meet or exceed the requirements for the batteries. No additional HVAC engineering shall be necessary for VRLA battery ventilation. The choice of mounting location should made based upon the location being clean and dust free. Do not choose a location where particulate matter is present from industrial processes or manufacturing.

D. Clearance

1. Clearance requirements follow compliance to NEC Section 110-26 requirements of 3 feet of open space in front of the inverter.

E. Floor Preparation

1. Mounting holes shall be provided in the base of each inverter cabinet. Each hole will accommodate 3/8" mounting hardware. It is recommended that all four holes are used when securing this unit. The floor shall support the dimensions and weight listed in "Section 8.0 Dimensions and Weights".

3.3 BEST PRACTICES

A. The following suggestions are recommended by the manufacturer based upon the substantial base of installed products throughout the world.

B. Inspections

1. Upon receipt of the inverter from the freight shipping company, inspect all cabinets and/or boxes for damage or potential impact. Should any damage be present, take pictures and fully document the occurrence. Any damage should be notated on the shipping carrier's Bill of Lading. This information should then be communicated to your local inverter representative.

C. Cabinet Modifications

1. At no time, should any inverter cabinet be modified. This includes drilling and cutting into the cabinet. Drilling or cutting the cabinet will cause metal shavings to be present which could ultimately fall onto electrical components causing a short in the unit. If you believe modification of the cabinet is necessary, please contact Inverter Tech Support to discuss.

END OF SECTION

SECTION 260951 - CENTRAL INVERTER FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Central Battery Inverter.

1.2 RELATED DOCUMENTS

A. This specification shall provide all electrical, technical and mechanical data relevant to the E3MAC Single-Phase Centralized Inverter system. The inverter shall supply Pure Sine Wave emergency power equivalent in quality to utility grade power. A high crest factor with substantial overload protection allows this inverter to drive difficult loads reliably.

B. Standards

   1. UL 924
   2. UL 65 KAIC tested per UL 61800-5-1
   3. NFPA 101 Life Safety Code
   4. NFPA 70 National Electrical Code
   5. ICC-ES AC 156 (Seismic Certification)
   6. IBC/CBC 2016
   7. ANSI C62.41: ANSI C62.45 (Category A & B)
   8. OSHA
   9. OSHPD Preapproval of Manufacturer's Certification (OPM)

1.3 FIELD CONDITIONS

A. RECOMMENDED LOCATION:

   1. The manufacturer recommends that all Inverter Cabinets reside in a dry, conditioned Space with normal ventilation. Relative Humidity shall be <95% non-condensing. All Cabinets are designed for NEMA Type-1 compliance.

B. OPERATING TEMPERATURE:

   1. Normal operating temperature is defined as between 68°F (20°C) to 86°F (30° C) Ambient temperatures above 77°F (25°C) will reduce the service life of the batteries.

C. STORAGE TEMPERATURE:

1. Storage before installation is critical for battery life expectancy and warranty. Batteries should be stored indoors in a clean, dry, and cool location. Storage at higher temperatures will result in accelerated rates of self-discharge and possible deterioration of battery performance and life. The recommended storage schedule based on temperature is as follows:

    a. 32°F (0°C) to 50°F (10°C) 9 Months
    b. 51°F (11°C) to 77°F (25°C) 6 Months
    c. 78°F (26°C) to 92°F (33°C) 3 Months

D. ELEVATION:

1. No derating required up to 1,600 Meters (5,280 ft.).
2. Apply derating of 2% per 125M up to maximum of 2,500 Meters (8,250 ft.) Consult factory for elevations greater than 2,500 Meters (8,250ft)

1.4 WARRANTY

A. Electronics Warranty

1. Refer to the standard Central Power Systems Warranty policy, which is available for download on the manufacturer's website. All information within the Central Power Systems Warranty supersedes this document.

B. Extended Manufacturer Warranty

1. The extended manufacturer's electronics warranty shall be for a period of 5 full years, if options Extended Warranty (EW) and Startup Commissioning (FS) are included.
2. Refer to the standard Central Power Systems Warranty policy, which is available for download on the manufacturer's website. All information within the Central Power Systems Warranty supersedes this document.

C. VRLA Batteries

1. The manufacturer's warranty on VRLA batteries follows the following warranty schedule:
    a. Repair or Replacement without charge - 1 year
    b. Pro-Rated Charge Repair or Replacement - 9 years

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The Central Inverter referenced within this specification document shall be the E3MAC Modular Inverter manufactured by Isolite Corporation in Trevose, PA. Substitutions:

1. Proposed substitutions (clearly delineated as such) must be submitted in writing for approval by Architect a minimum of 10 working days prior to bid date and must be made available to all bidders. Proposed substitutes must be accompanied by review of specification noting compliance on line-by-line basis.

B. Manufacturer Quality Assurance:

1. Manufacturer shall be registered to the ISO 9001:2015 quality standards.

2.2 REQUIREMENTS

A. Furnish and install an Isolite E3MAC Modular Single-Phase Inverter that meets the following requirements for a minimum time period of 90 minutes:

1. Input Voltage 277 VAC
2. Output Voltage 277VAC
3. Rating kW/kVA as shown on inverter schedule

2.3 INPUT SPECIFICATIONS

Phase Configuration	Split Phase (3-wire plus ground)
Input Voltage	277V
Operating Range	± 10% Nominal Utility Voltage
Frequency Range	Hz ± 3 Hz
Power Factor	Lag/0.5 Lead [1]
Current Limit	125%
Efficiency	98%
Surge Protection	Compliant and tested per UL 924
Brown-Out Protection	87.5% of Nominal Utility Voltage
Short Circuit Withstand	65 KAIC

2.4 OUTPUT SPECIFICATIONS

Output Voltage	277V as specified
Crest Factor	≥ 4.0
Overload Capability	120% for 10 minutes, 400% for 500mS
Load Power Factor	2.5 Lag/0.5 Lead [2]
Power Factor Rating	KW = KVA [2]
Harmonic Distortion	≤ 3%
Frequency Range	60Hz +/- 0.02 Hz crystal controlled during emergency mode
Transfer Time	Less than 2mS (fast transfer)

ConfigurationOutput Configuration	Configured for Normally On operation (See Section 6.0 for Normally Off or Switched options)

2.6 BATTERY

Run Time	90 Minutes
Type	VRLA Maintenance-Free Lead Calcium
Charging	Three Rate Charger circuit fully temperature compensated
Recharge Time	≤ 24 hours
Buss Voltage	48VDC through 144VDC (model dependent) 2.27V Float Voltage per cell 1.67-1.70 Low Voltage Disconnect per cell
Battery Warranty	1 year full, 9 years pro-rata
Fire Safety	Flame Retardant UL 94V-0
Design	Front Terminal (ease of access)
Battery Approval	IEC 60896-21 and 60896-22 Certified UL Certified

A. Input Power factor is heavily influenced from pass-through of connected load

B. The inverter can support wide power factor variations (0.5 Lag/0.5 Lead); however, the unity Power Factor Rating (KW=KVA) specifies the maximum output limits that cannot be exceeded.

1. Design
   a. Modular Design - The inverter construction shall use a modular technique so that sizes shall be available in increments from 1.0 to 12.5 kVA capacities. Modules shall be interconnected to build the required system capacity and shall be field-upgradable to increase system size. Inverter modules shall be high frequency Pulse Width Modulated (PWM) using isolation transformers and IGBT or MOSFET switching schemes which allow for high quality pure sine wave and multi- voltage capabilities.
   b. Convection Cooling - Thermal design performance shall achieve 100% reliance on natural convection during the standby or "Normal Operation" mode (99.9% of product life). Fans shall only be operational during "Emergency Operation" mode and bulk re-charging of the batteries. This increases efficiency, improves reliability, and eliminates the need for air filters and routine dust-removal maintenance commonly found with units employing continuous operation fans.
   c. Front Access - All inverters shall utilize a front-facing access door on both the inverter cabinet and battery cabinet. The All inverters shall utilize a front-facing access door on both the inverter cabinet and battery cabinet. The batteries utilized in these units have front facing terminals. This design allows for easy access for troubleshooting and battery installation from the front face with no side access required.
   d. DC Isolation from AC - Batteries shall have isolation from the incoming or outgoing AC line voltage and Earth Ground. This feature allows a direct short between any battery-to-chassis ground without damage. Minimum impedance to chassis ground shall be 100 kOhms.

e. Short Circuit Withstand Capability - The Inverter's internal AC distribution shall be capable of a short circuit withstand of 65,000 Ampere Interrupting Capacity (65 KAIC). The inverter shall be tested and listed in compliance with the IEC testing standards UL 61800-5-1 and shall also include this rating when using optional output circuit breakers which are UL 489 rated.
f. Inverter Compliance - The inverter shall be tested and listed by Underwriters Laboratory to the UL 924 standard which also includes the Self-testing and Self-Diagnostic portion of the standard. Self-Testing shall be performed monthly for a minimum of 30 seconds and annually for a minimum of 90 minutes to comply and also contain fully programmable, password protected Load-Reduction fault programming capabilities.
g. User Interface/Alarms - The inverter shall include an intuitive four-line, 20 character LED-backlit display and five button keypad user interface referred to as the Man-Machine Interface (MMI). This interface shall allow the user to scroll through all meters, alarms, test logs and programming functions via the keypad and display. An SD Memory Slot and Mini-USB connection shall also allow for easy offloading of events/records.

C. MMI FEATURES

1. The following features are standard on all modular inverters.

2. Password Protected
   a. All user configurable system features exist in a Password Protected menu within the unit.

3. One-Button System Test
   a. UL 924 compliance is easily achievable by the press of one button on the front panel of the inverter. A 30 second test will initiate self-testing and self-diagnostics by analyzing battery voltages and output loads.

4. Scheduled Testing
   a. The inverter can be programmed to automatically perform monthly and annual 90-minute NFPA compliance tests. User can specify minute, hour, day and month.

D. METERING FUNCTIONS

1. The MMI shall allow the user to monitor the following meter functions via the LCD screen:
   a. Input Voltage (L-N)
   b. Output Voltage (L-N)
   c. Output Current
   d. Output VA
   e. Battery Voltage
   f. Battery Current
   g. Battery Power
   h. Temperature
   i. System Days
   j. Inverter Minutes
   k. Inverter Events

2.7 ALARMS

A. The active alarms shall be displayed in the Alarm Menu when alarms are present. All alarms shall signal the user with both an Audible Alarm and a Visual Alarm LED on the unit's front panel.

1. Startup Mode Alarms
Communication, Setup Conflict, Battery Voltage, Back- Feed, Transfer /AC Fuse, Overload, Mis-Wire, Incorrect AC (Fixed Alarms, Not Configurable)

2. Charger Mode Alarms
Communication, Over-Temperature, DC Fuse, No Charge, Overcharge, Back-Feed, AC Fuse/Wiring, Program Reference (Fixed Alarms, Not Configurable)

3. User Programmable Alarms
Low Battery, Near Low Battery, High Temperature, Utility Failure, Low VAC, High VAC, Load Reduction. (Password Protected, Configurable)

B. Onboard Event/Test/Alarm Logging

1. Event Logs, Test Logs and Alarm Logs shall be stored on board the inverter's MMI. The system shall store up to 1000 of each type in a First in - First out process. All data can be downloaded via local SD, local USB, and the Remote Web Monitoring system.

2. Event Log - During an Event, the system shall keep a record of each critical parameter Including: Start/End Time, Date of the event, Start/End Output Voltage (Phase A, B, and C), Start/End Output Current (Phase A, B, and C), Start/End Output VA (Phase A, B, and C), Start/End Battery Voltage, Battery Current, Start/End Temperature

3. Test Log - Identical to the Event Log with the exception that the Test Log is only stored when a system test is either: User Initiated by pressing the Test Button on the front panel keypad or via the "Test Button" on the Remote Web Monitoring system control panel OR When the system is instructed by the programmable automatic monthly or yearly test

4. Alarm Log - In the event an alarm occurs from any of the sources detailed in Section 2.8, the alarm is immediately stored into memory.

C. User Setup Menu:

1. The password protected User Menu shall allow adjustments to the following parameters:
   a. Date (MM,DD,YY)
   b. Time (24hr)
   c. Month Test
   d. Year Test
   e. Low VAC Alarm
   f. High VAC Alarm
   g. Near Low Battery Alarm
   h. Utility Failure Alarm
   i. High Temperature Alarm
   j. Time Delay
   k. Load Reduction Alarm

l. Alarm Relay(s)
m. Backup Logs
n. Contact Name
o. Contact Phone Number

2.8 QUALITY ASSURANCE

A. Manufacturer Testing

1. All inverters shall be manufactured in Trevose, PA. End-of-line quality tests shall be performed by the build team. Each unit produced shall be 100% load tested and run through a series of durability tests, fault tests and unit-specific option tests by the Quality Control Team. The inverter shall then be inspected a third time to ensure 100% specification compliance prior to shipping.

B. SELF TESTING

1. Each inverter shall utilize several different methods of self-testing. On start-up, each unit shall test the following prior to entering Normal Operation Mode: Communications, Set-Up Conflict, Low Battery, Back-feed, Transfer/AC Fuse, Short/Overload, Miswire, and Incorrect AC Input. Scheduled Self-Tests can be programmed into the unit for Monthly tests and Yearly 90 minute NFPA compliance tests. In addition, each unit shall continuously test itself and notify users of issues via the Onboard Diagnostics and the LifeGuard Online Remote Monitoring.

2.9 FABRICATION

A. Cabinet Construction

1. The inverter cabinets shall be made from 14 gauge cold-rolled steel. All corners and seams shall be welded and ground smooth before powder coating. Internally, each inverter module and shelf shall have galvanized or painted steel parts to resist corrosion and provide high durability. There is no visible hardware on the outside of the cabinet, with all components contained within the enclosure. Each cabinet design shall have multiple pre- punched Electrical Knock Outs (EKO) on the top and sides for quick and clean conduit installation by a qualified electrician. Seismic Certified Brackets shall be available as an option (see Section 7.0 "Options"). All Cabinets are designed for NEMA Type-1 compliance.

B. Cabinet Finish

1. Each inverter cabinet is powder coated with 2-tone TIGER Drylac®. Cabinet: TIGER Drylac® Texture Matte Finish Powder Coat - 09/71420 RAL 7016 (GREY) Door: TIGER Drylac® Texture Smooth Finish Powder Coat - 49/73510 RAL 7035 (LT GREY)

C. Manufacturing Method/Location

1. Each inverter shall be designed, developed, and manufactured in Trevose, PA. Each unit shall be built to order and therefore fully custom. Each unit shall be 100% tested for an extended period of time before being released to be shipped.

2.10 Trip Alarm (option code - TA)

A. When Trip Alarm Breakers are purchased, the inverter shall monitor each of those outputs for tripping. If any of the breakers trip, the unit will broadcast an alarm.

2.11 Terminal Block (option code - TB)

A. 1 Summary / 2 Programmable terminal blocks. Allows inverter operations to be output to a BMS System via a Form C dry contact closure. The programmable terminal block can be field or factory configured for the following:

1. AC Present
2. Battery Charging
3. High-Temperature Alarm
4. Utility Failure Alarm
5. Near Low Battery Alarm
6. Low Battery Alarm
7. High VAC Alarm
8. Low VAC Alarm

2.12 Keyed Lock (option code - KE)

A. This option shall add a lock and key to the cabinet to prevent unauthorized entry.

2.13 Extended Electronics Warranty (option code - EEW)

A. Extended Electronics Warranty can be purchased if the Factory Startup (FS) option has been purchased with the unit. The extended warranty period shall be for 5 years. For more information, please see "Section 9.0 Warranty".

2.14 Factory Startup (option code - FS)

A. Factory Startup shall include a visit from a factory-certified technician for inverter activation and demonstration. This option automatically extends the factory warranty from 2 years to 3 years.

2.15 Wall Mount (option code - WB)

A. A wall-mount option is available for the 1kVA unit only.

2.16 BMS Integration (option code - BI)

A. This option allows for the integration of BACNet/MSTP, BACNet/IP, ModBus, and ModBus/RTU systems with the E3MAC inverter system. Alarms and real-time information generated from the E3MAC system are propagated to the BMS system.

2.17 The standard output configuration on all inverters shall be Normally On. Breakers can be added to any output type. Breakers shall be a UL 489 type approved for field wiring and maintain a 65KAIC rating. (See ordering guide for available breaker and trip alarm configurations)

A. Normally On Output

B. Shall be energized 24/7 in all modes.

2.18 Normally Off Output

A. Shall only be energized in Emergency Operation Mode.

2.19 Switched Output

A. Shall be energized/de-energized with a switched command signal. In Emergency Operation Mode the load shall be energized regardless of the switch command signal.

2.20 NORMAL OPERATION (PASS-THROUGH MODE)

A. When normal utility power is present, the inverter shall run in Pass-Through Mode. Utility Power will be the source of power for all circuits, simply passing through the inverter unit to supply those circuits. The inverter unit will consume a small amount of power to run internal monitoring circuits and provide float charging to the battery circuit.

2.21 EMERGENCY OPERATION (DISCHARGING MODE)

A. When a loss of utility power occurs on any phase, the inverter shall detect this and switch to Discharging Mode. The inverter shall transfer to supplying AC to the connected circuits in less than 2 mS. Once utility power is restored, the inverter shall switch back to using utility power to supply the connected circuits.

2.22 RECHARGE OPERATION (CHARGING MODE)

A. The inverter shall revert to Charging Mode when utility power is returned to the unit. If batteries are fully depleted, they shall be fully recharged within 24 hours. The Three Rate Charger circuit is fully temperature-compensated for added reliability.

PART 3 - EXECUTION

3.1 Factory Start-up (Onsite Commissioning)

A. Factory Start-up shall be an available option on all inverters (option FS, see section 7.10). Using the manufacturer's Field Service to start-up the unit will ensure proper installation, system longevity, and extend the standard electronics warranty from 2 years to 3 years. Factory Startup shall include, but is not limited to the following:

1. Perform visual inspection of all input and output connections made by electrician
2. Inspect all bolts and battery buss bars for proper torque specification
3. Setup and configure all settings, alerts and alarms per specification
4. Calibrate the inverter
5. Run diagnostic tests and alert/alarm tests
6. Record all current settings on inverter to set a baseline for future servicing
7. Perform training for user or point of contact when present
8. Setup Remote Web Monitoring system per specification
9. Test all modes of operation: Normal Mode, Emergency Mode, and Charging Mode

B. Contractor shall connect diagnostic alarm contact closures to the nearest MetaSys panel and integrate in the CCMS for remote monitoring of an alarm condition.

3.2 SITE REQUIREMENTS

A. The following Site Requirements are imperative to proper system installation.

B. Battery Chemistry

1. The inverter shall be supplied with Valve Regulated Lead Acid (VRLA) batteries standard. These VRLA Batteries shall use Absorbent Glass Material (AGM) as the separator and utilize Recombinant Technology, which helps minimize gas emissions. The electrolyte used in the VRLA batteries shall not exceed 50 gallons in total, which is compliant with current IFC/UFC codes.

C. Ventilation

1. As previously stated in section "2.6.2 Convection Cooling", each inverter shall be cooled by natural convection. For VLRA battery systems, the ventilation requirements for human occupancy and electronic equipment will meet or exceed the requirements for the batteries. No additional HVAC engineering shall be necessary for VRLA battery ventilation. The choice of mounting location should made based upon the location being clean and dust free. Do not choose a location where particulate matter is present from industrial processes or manufacturing.

D. Clearance

1. Clearance requirements follow compliance to NEC Section 110-26 requirements of 3 feet of open space in front of the inverter.

E. Floor Preparation

1. Mounting holes shall be provided in the base of each inverter cabinet. Each hole will accommodate 3/8" mounting hardware. It is recommended that all four holes are used when securing this unit. The floor shall support the dimensions and weight listed in "Section 8.0 Dimensions and Weights".

3.3 BEST PRACTICES

A. The following suggestions are recommended by the manufacturer based upon the substantial base of installed products throughout the world.

B. Inspections

1. Upon receipt of the inverter from the freight shipping company, inspect all cabinets and/or boxes for damage or potential impact. Should any damage be present, take pictures and fully document the occurrence. Any damage should be notated on the shipping carrier's Bill of Lading. This information should then be communicated to your local inverter representative.

C. Cabinet Modifications

1. At no time, should any inverter cabinet be modified. This includes drilling and cutting into the cabinet. Drilling or cutting the cabinet will cause metal shavings to be present which could ultimately fall onto electrical components causing a short in the unit. If you believe modification of the cabinet is necessary, please contact Inverter Tech Support to discuss.

END OF SECTION

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

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 each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Electric Corporation.
2. Eaton.
3. General Electric Company.
4. Jefferson Electric, Inc.
5. Powersmiths International Corp.
6. Siemens Power Transmission & Distribution, Inc.
7. Sola/Hevi-Duty; a brand of Emerson Electric Co.
8. Square D; by Schneider Electric.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. 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.

C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.

D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

E. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum or Copper.

F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated.

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound utilizing a vacuum pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Manufacturer's standard gray.

E. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.. Coordinate with Mechanical for heat dissipation

H. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 -deg C rise above 40-deg C ambient temperature.

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper or aluminum electrostatic shield arranged to minimize interwinding capacitance.

K. Wall Brackets: Manufacturer's standard brackets.

L. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40 dBA.
2. 30 to 50 kVA: 45 dBA.
3. 51 to 150 kVA: 50 dBA.
4. 151 to 300 kVA: 55 dBA.
5. 301 to 500 kVA: 60 dBA.
6. 501 to 750 kVA: 62 dBA.
7. 751 to 1000 kVA: 64 dBA.
8. 1001 to 1500 kVA: 65 dBA.

2.4 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 Section 260553 "Identification for Electrical Systems."

2.5 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 the rated voltage connections and at all tap connections.
2. Ratio tests at the rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at the rated voltage connections.
4. No load losses, and excitation current and rated voltage at the rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at the 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.

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, floors, roofs, and concrete bases 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. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

    1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

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 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "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-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 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 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 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "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 that allows adjustments.

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. Keys: Two spares for each type of panelboard cabinet lock.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards 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.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager no fewer than 7 days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.
3. Comply with NFPA 70E.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. 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.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.

2. Height: 84 inches maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
4. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

F. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity for panelboards rated less than100 amps.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity for panelboards rated less than 100 amps.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: Ten percent.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 1000 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

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:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; by Schneider Electric.

C. Panelboards: NEMA PB 1, distribution type.

D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

E. Mains: Circuit breaker or Lugs only.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

G. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

H. All main circuit breakers shall be LSI Electronic Trip.

I. All branch breakers 100 amp and above shall be LSI Electronic Trip.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; by Schneider Electric.

C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

D. Mains: Circuit breaker or lugs only.

E. All main circuit breakers shall be LSI Electronic Trip.

F. All branch breakers 100 amp and above shall be LSI Electronic Trip.

G. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

H. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

I. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; by Schneider Electric.

C. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.
b. Instantaneous magnetic trip element for short-circuits.

2. Electronic Trip Circuit Breakers:

    a. RMS sensing.
    b. Field-replaceable rating plug or electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.
    e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    f. Integral test jack for connection to portable test set or laptop computer.
    g. Field-Adjustable Settings (Refer to the Drawings for setting requirements):

        1) Instantaneous trip.
        2) Long- and short-time pickup levels.
        3) Long and short time adjustments.
        4) Ground-fault pickup level, time delay, and I squared T response.

3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
5. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
7. Subfeed Circuit Breakers: Vertically mounted.
8. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings.
    d. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    g. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system as indicated on documents.
    h. Shunt Trip: trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
    j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
    k. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    l. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.

m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NECA 407.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

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, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NECA 407.

D. Equipment Mounting:

1. Install floor-mounted panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box.

G. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

H. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.

I. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

O. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. 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.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 262726 - 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. Section Includes:

1. Standard-grade receptacles.
2. GFCI receptacles.
3. Toggle switches.
4. Occupancy sensors.
5. Wall plates.
6. Poke-through assemblies.

1.3 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. Comply with NEMA WD 1.

D. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

E. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

F. Device Color:

1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.

G. Wall Plate Color: For plastic covers, match device color.

H. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES

A. Duplex Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596. :

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding.

B. Tamper-Resistant Duplex Receptacles, 125 V, 20 A :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.3 USB RECEPTACLES

A. USB Charging Receptacles :

1. USB Receptacles: Dual and quad, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
2. Standards: Comply with UL 1310 and USB 3.0 devices.

2.4 GFCI RECEPTACLES

A. Duplex GFCI Receptacles: 125 V, 20 A; comply with NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596. :

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.

3. Type: Feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Weather-Resistant Duplex GFCI Receptacle: 125 V, 20 A; comply with NEMA WD 6 Configuration 5-20R, UL 498, :

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.5 TOGGLE SWITCHES

A. Single-Pole Switches: 120/277 V, 20 A; comply with UL 20, and FS W-S-896. :

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. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

B. Three-Way Switches: 120/277 V, 20 A; comply with UL 20, and FS W-S-896. :

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. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2.6 OCCUPANCY SENSORS

A. Wall Switch Sensor Light Switch, Dual Technology :

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. Leviton Manufacturing Co., Inc.
   b. Lutron

2. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.
3. Standards: Comply with UL 20.
4. Adjustable time delay of 20 minutes.
5. Able to be locked to Manual-On mode.
6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
7. Connections: Integral wireless networking.

2.7

2.8 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: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
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 with lockable cover.

2.9 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand (Pass & Seymour).
3. Square D; by Schneider Electric.
4. Wiremold / Legrand.

C. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.

D. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. 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 the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with 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 the outlet box is large enough.

D. 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 protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. 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 do not cover rough wall opening.

F. 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.

G. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black -filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. Include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. 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.

C. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with 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 individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices.

C. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

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SECTION 263213.16 - GAS-ENGINE-DRIVEN GENERATOR SETS

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. Engine.

B. Related Requirements:

1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. LP: Liquefied petroleum.

D. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Provide Generator exhaust emission calculations for MMAC's Air Permit with the Oklahoma Department of Environmental Quality (ODEQ)

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

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. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. GE Power.
4. Generac Power Systems, Inc.
5. Hipower Systems.
6. Kohler Power Systems.
7. MTU Onsite Energy Corporation.

B. Source Limitations: Obtain packaged engine generators and auxiliary components through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. B11 Compliance: Comply with B11.19.

B. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.

E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 104 deg F.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.

C. Power Rating: Standby.

D. EPSS Class: Engine generator shall be classified as Class 96 according to NFPA 110.

E. Service Load: 250kW .

F. Power Factor: 0.8, lagging.

G. Frequency: 60 Hz.

H. Voltage: 480 V ac.

I. Phase: Three-phase, four wire, wye.

J. Induction Method: Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

M. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:

    a. Comply with NFPA 110, Type 10 system requirements.

2.4 GAS ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.

D. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

E. Muffler/Silencer:

1. Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 12 dB at 500 Hz.
    b. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 90 dBA or less.

F. Air-Intake Filter: Standard -duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

G. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

2.5 GAS FUEL SYSTEM

A. Natural Gas Piping: Comply with requirements in Section 231123 "Facility Natural Gas Piping."

B. Natural Gas, Vapor-Withdrawal System:

1. Carburetor.
2. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
4. Fuel Filters: One for each fuel type.
5. Manual Fuel Shutoff Valves: One for each fuel type.
6. Flexible Fuel Connectors: Minimum one for each fuel connection.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine generator battery.

E. Control and Monitoring Panel:

1. Digital controller with integrated LCD, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Instruments: Located on the control and monitoring panel and viewable during operation.

   a. Engine lubricating-oil pressure gage.
   b. Engine-coolant temperature gage.
   c. DC voltmeter (alternator battery charging).
   d. Running-time meter.
   e. AC voltmeter, connected to a phase selector switch.
   f. AC ammeter, connected to a phase selector switch.
   g. AC frequency meter.
   h. Generator-voltage adjusting rheostat.

3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication, including the following:

   a. Run-Off-Auto switch.
   b. Control switch not in automatic position alarm.
   c. High engine temperature prealarm.
   d. High engine temperature.
   e. High engine temperature shutdown device.
   f. Overspeed alarm.
   g. Overspeed shutdown device.
   h. Battery high-voltage alarm.
   i. Low cranking voltage alarm.
   j. Battery-charger malfunction alarm.
   k. Battery low-voltage alarm.
   l. Contacts for local and remote common alarm. Connect to buildings MetaSys/CCMS system to alert building maintenance staff through BAS.

F. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Run-Off-Auto switch.
2. Control switch not in automatic position alarm.
3. Low cranking voltage alarm.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case circuit breaker, thermal-magnetic type; 100 percent rated; complying with UL 489:

a. Tripping Characteristic: Designed specifically for generator protection.
b. Trip Rating: Matched to generator output rating.
c. Mounting: Adjacent to or integrated with control and monitoring panel.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph.

B. Hinged Doors: With padlocking provisions.

C. Space Heater: Thermostatically controlled and sized to prevent condensation.

D. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.

F. Gaseous Fuel Piping:

1. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."

G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Gaseous Fuel Connections:

1. Connect fuel piping to engines with a gate valve and union and flexible connector.
2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
3. Vent gas pressure regulators outside building a minimum of 60 inches from building openings.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

F. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213.16

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SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes automatic transfer switches rated 600 V and less.

1. Bypass/isolation switches.
2. Remote annunciator system.

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 transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include material lists for each switch specified.
2. 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.
3. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for three cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Service-Rated Transfer Switch:

1. Comply with UL 869A and UL 489.
2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
3. Surge Protective Device: Service rated.
4. Ground-Fault Protection: Comply with UL 1008 for normal and alternative buses.
5. Service Disconnecting Means: Externally operated, manual mechanically actuated.

J. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

K. Integral Isolation Bypass.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

M. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

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. Cummins Power Generation. Or equal.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.
6. Main and Neutral Lugs: Compression type.
7. Ground Lugs and Bus-Configured Terminators: Compression type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

F. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

G. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

H. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

I. Integral Isolation Bypass.

J. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

2.3 TRANSFER SWITCH ACESSORIES

A. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Switch position.
c. Switch in test mode.
d. Failure of communication link.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. 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.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.

g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
3. Provide workspace and clearances required by NFPA 70.

B. Identify components according to Section 260553 "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

F. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

G. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that the unit is clean.
    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of all control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
    k. Perform visual and mechanical inspection of surge arresters.
    l. Inspect control power transformers.

        1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
        2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
        3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

    a. Perform insulation-resistance tests on all control wiring with respect to ground.
    b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
    c. Verify settings and operation of control devices.
    d. Calibrate and set all relays and timers.
    e. Verify phase rotation, phasing, and synchronized operation.
    f. Perform automatic transfer tests.
    g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. 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.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and 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 retransfer from 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 microhms and values for one 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.

6. 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. Coordinate tests with tests of generator and run them concurrently.

C. 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.

D. Transfer switches will be considered defective if they do not pass tests and inspections.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 263601 - GENERATOR DOCKING STATION

PART 1 - GENERAL

1.1 GENERAL

1.2 QUALITY ASSURANCE

A. 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.

B. ETL/UL LISTED to 1008 Standards

C. UL 50 LISTED

1.3 COORDINATION

A. Coordinate layout and installation of Generator Docking Station, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels

1.4 GUARANTEE/WARRANTY

A. Manufacturer Warranty shall be provided for a minimum of 1 Year,

B. The equipment installed under this contract shall be left in proper working order

C. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 - PRODUCTS

2.1 DOCKING STATION

A. Manufacturers: Basis of Design:

1. TRYSTAR: Rotary Docking Station (Refer to Sheet EP607)

2.2 GENERAL REQUIREMENTS

A. Enclosure

1. NEMA 3R Rain-Tight Aluminum Enclosure

a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
b. NEMA 3R Integrity shall be maintained while temporary cabling is connected during use
c. Front and Side shall be accessible for maintenance
d. Top, Side, and Bottom shall be accessible for permanent cabling

2. Powder coat

a. Paint after fabrication shall be Hammer tone Gray

B. Phase, Neutral, and Ground Busbar

1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 50% of phase size.
5. Neutral Bus: Neutral bus rated 100 percent of phase bus.

C. Temporary generator and Load Bank connectors shall be Camlok style mounted on gland plate.

1. Camlok shall be 16 Series model and color coded according to system voltage requirements.
2. Camlok connections shall be Bus Bar Style, Cabling or Double Set Screw is not acceptable
3. Camlok connection shall be protected against accidental contact while not in use

D. Permanent Connection shall be factory installed broad range set-screw mechanical type, located behind a physical barrier

E. Short Circuit & Withstand Rating

1. Shall be minimum 65 KAIC unless otherwise indicated on drawings

F. Voltage & Amperage

1. 480/277 volts, 200 amps.

G. Factory Installed Phase Rotation Monitor Device:

1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and factory installed

H. Optional Breaker Disconnects as Indicated on Project Drawings and Manufacturer Submittal Drawings:

1. Must be UL 489 Listed Breaker
2. Breakers shall be removable for service and maintenance

I. Additional accessories shall be included in submittal drawing as follows:

N: Strip Heater & Thermostat

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive Generator Docking Station for compliance with 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. Surface, Flush or Base Mounted: Determined by Application

1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Third Party Tests and Inspections to include the following:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results. Include notation.

END OF SECTION 263601

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SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 262413 "Switchboards" for factory-installed SPDs.
2. Section 262416 "Panelboards" for factory-installed SPDs.

1.2 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. ABB France.
2. Eaton Corporation.
3. Emerson Electric Co.
4. GE Zenith Controls.
5. Leviton Manufacturing Co., Inc.
6. Schneider Electric Industries SAS.
7. Siemens Industry, Inc.

2.2 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be at least 125 percent of the nominal system voltage.

2.3 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

A. SPDs: Comply with UL 1449, Type 1.

B. Comply with UL 1283.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

2.4 PANEL SUPPRESSORS

A. SPDs: Comply with UL 1449, Type 1, unless otherwise noted on the drawings.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.$ds~Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

C. Comply with UL 1283.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Neutral to Ground: 1200 V for 480Y/277 V.
4. Line to Line: 2000 V for 480Y/277 V

2.5 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

2.6 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior Solid-state luminaires that use LED technology

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including LEDs, reflector, housing, driver, and all associated appurtenances.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated in the luminaire fixture schedule .

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all part types used on Project; use ANSI and manufacturers' codes.

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. Drivers and LEDs: Two for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. 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.

B. Standards:

1. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
2. Recessed luminaires shall comply with NEMA LE 4.

C. CRI as indicated on drawings.

D. Rated LED life of 80,000 hours to L70.

E. Fixture dimmable from 100 percent to 1 percent of maximum light output, unless otherwise noted.

F. Nominal Operating Voltage: as indicated on drawings.

G. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.2 MANUFACTURERS:

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or equivalent . Equivalency to be determined at the sole discretion of the Project Engineer.

B. Minimum allowable efficacy of 100 lumens per watt.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended LEDs and drivers. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gauge.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

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. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Each luminaire shall contain installed LEDs and drivers.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.
4. Installation shall minimize light leakage.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

5. Wiring diagrams for power, control, and signal wiring.

6. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Sustainable Design Submittals:

1. Product Data: BUG ratings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of the following:

1. Luminaire.

C. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and 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. Glass, Acrylic, 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.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures, including luminaire support components.
   b. Faulty operation of luminaires and accessories.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. 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.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598 and listed for wet location.

D. Minimum CRI of 70. CCT as indicated.

E. L70 lamp life of 50,000 hours.

F. Internal driver.

G. Nominal Operating Voltage: as indicated .

H. Lamp Rating: Lamp marked for outdoor use.

I. Source Limitations: Obtain luminaires from single source from a single manufacturer.

J. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 FINISHES

A. Variations in Finishes: 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.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

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. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls Attached to a minimum 1/8 inch backing plate attached to wall structural members.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CORROSION PREVENTION

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 Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

END OF SECTION

SECTION 275319 - FIRST RESPONDER DISTRIBUTED ANTENNAE SYSTEMS (DAS)

(Bid Option #6)

PART 1 - GENERAL

1.1 SUMMARY

A. This work includes design and providing a new, complete, passive distributed antenna system (DAS) as required and as described herein for the FAA. Provide a turnkey system capable of receiving, processing, and transmitting indicated radio signals including the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, active components, passive components, mounting hardware and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. The new Headquarters Building ERRCS must be networked via optic fiber to the existing ERRCS at the FAA's MMAC Multi-Purpose Building. The new ERRCS system in the HQB must be compatible with the existing Honeywell Fiplex system in MPB. Provide system complete and ready for operation. See paragraph titled SYSTEM DESCRIPTION for additional requirements.

B. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required provisions of NFPA 70, NFPA 72 and NFPA 1221.

C. The system layout on the drawings shows the intent of coverage and are shown in suggested locations. Submit plan view drawing showing all component locations, cable routing, junction boxes, other related equipment, conduit routing, and wire counts for all floors.

D. Provide a DAS capable of receiving, processing, and transmitting first responder, military and local emergency medical services (EMS), radio paging and required UHF and VHF frequencies. Provide initial system capable of processing services of frequencies provided by jurisdiction. Provide a system that is upgradeable to allow future additional frequencies as required by NFPA 1221.

E. Provide letters of permission for all used frequencies for which the Government does not already have a license.

1.2 DEFINITIONS

A. System Integrator

1. A person or organization that specializes in distributed antenna systems in bringing together component subsystems into a complete system and ensuring that those subsystems function together as a complete system. The system integrator is responsible for the system design, installation, testing including all warranties required by this specification.

1.3 RELATED SECTIONS

A. Section 078400 FIRESTOPPING for additional work related to firestopping.

1.4 SYSTEM DESCRIPTION

A. Design Requirements

1. Provide a Distributed Antenna System (DAS), capable of distributing first responder radio signals from equipment including communication links, antenna systems, bi-directional amplifiers, coaxial cabling, broadband repeaters in necessary bandwidths to support desired frequencies, couplers, decouplers, battery backup, power line surge protection and all other necessary components to make a complete and operational system. Provide a complete and operational system to distribute system two-way radio service from the first response radio system.

2. Complete coverage in accordance with NFPA 1221 will be provided for all interior spaces including mechanical areas, open stairwells, storage areas and basement.

3. Provide all headend interface, antenna interfaces and amplification components, conditioners and any other equipment necessary.

4. Provide system features that include, at a minimum, frequency conditioners, auto isolation detection (Uplink/Downlink) and auto turn on-off (Downlink) functions to ensure that the repeater unit is optimally always positioned and safe guarded. It will also have LED displays to show uplink and downlink connection, as well as LED lights for power and uplink and downlink alarms.

5. Provide all materials and labor needed for a complete and operational system for the services in this specification plus the additional system capabilities as indicated. This includes but not limited to all necessary equipment, interfaces, jumpers, terminations, cabling, antennas, amplifiers, conditioners, power supplies, battery backup, software and all components required to attach access points to the system.

B. System Application Design

1. Provide the system application design required to provide a DAS that complies with and satisfies all the requirements specified in this Section and as indicated on the Fire Alarm Drawings for this application and project.

C. Standard Products

1. Provide an application design that utilizes standard system components that are the product of a Manufacturer regularly engaged in the manufacture of DAS, and that have been in satisfactory use for at least six months. The System must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the facility.

2. Provide hardware, software, and installation of a complete and engineered system. Provide a submitted design that is properly engineered for the operational requirements. Include all components required to meet this specification section in the design, other than a change in, or in addition to the operational frequencies identified herein.

D. Local Products

1. Incorporate local materials to the greatest extent possible. All proposed local products must meet all applicable hardware and software requirements set forth in these specifications.

E. Minimum Requirements

1. Specifications are minimum requirements. If the provided system requires enhanced specifications that exceed those specified herein to satisfy the specified design, configuration, capability, and performance requirements, then provide a system with the enhanced specifications.

F. Current State-of-the-Art Technology

1. Provide DAS application design and products that utilize current state-of-the-art products that provide the enhanced capability and performance specified herein. Provide DAS design and products representing the latest manufacturer make and model.

G. Continuous Duty Design

1. Provide equipment designed for 24 hours per day, 365 days per year continuous 100 percent duty operation.

H. Design Analysis and Calculations

1. Provide a comprehensive design analysis and calculations to I, at a minimum, the following:

a. Power supply requirements for each component of the system in accordance with the manufacturer's instructions and the worst-case loading conditions for power supplies that are not part of the component. Provide power consumption and dissipation data under normal and maximum operating conditions.
b. Cable type, size, and attenuation calculations for all cables connecting the components of the system according to manufacturer's instructions.
c. Definition of all interface protocols and specific preparation and application items including coordination issues.
d. Signal calculations and anticipated signal strength for various areas of the buildings.
e. Frequencies of operation and the transmission characteristics throughout the facility.
f. Number of concurrent users per frequency and service.
g. Uninterruptible power supply meeting the secondary power source requirements of NFPA 1221 and UL 924.
h. System monitoring meeting the requirements of NFPA 1221 for Two-Way

I. Radio Communications Enhancement Systems Environmental Requirements.

1. Provide equipment to be used indoors rated for continuous duty operation under ambient environmental conditions of 35 to 120 degrees F dry bulb and 10 to 95 percent relative humidity, noncondensing. Provide all other equipment rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

J. Electrical Requirements

1. 105 VAC to 130 VAC at 60 Hz operating voltage range, plus or minus 2 percent.

K. Power supplies

1. Provide primary and secondary power supplies in accordance with NFPA 1221 that provide sufficient power for worst-case conditions of system operation that could occur without signal loss or perceptible degradation. The system shall be connected to the generator for life safety power. Provide power supply monitoring in accordance with NFPA 1221.

L. Power Line Surge Protection

1. Provide power line surge protection for all equipment connected to AC power. Provide surge protection integral to the equipment or installed as an accessory item in accordance with manufacturer's recommendations. Do not use fuses for surge protection.

M. Antenna Line Surge Protection

1. Provide power line surge protection for all equipment connected to a radio antenna. Provide surge protection in accordance with manufacturer's recommendations. Do not use fuses for surge protection.

N. Shielding and Grounding

1. Provide shielding and grounded as required by the system design, Manufacturer's instructions, FCC Part 15 listing, and regulatory requirements.

O. System Capability and Configuration

1. System Capability

a. Provide a DAS to support all indicated frequencies and services.
b. Coordinate requirements for interfacing with the trunked radio system which supports fire and police departments and emergency personnel with the Owner.

1.5 System Configuration and Major Functional Components

A. Provide system of automatically controlled bi-directional amplifiers (BDA), antennas, decoupling cavities, coaxial cables, fiber optic cables, related filtering devices engineered into one tuned system that will accomplish the specified functionality on all specified frequencies.

B. Performance Requirements

1. Provide DAS coverage within the facility in accordance with NFPA 1221 and as follows:

a. 99 percent floor area radio coverage for critical areas such as fire riser rooms, exit passageways, elevator lobbies, standpipe cabinets, basement, fire suppression valve locations, Director's Suites and all areas of refuge.
b. 90 percent floor area radio coverage for general building areas.

C. System Initiation and Operation

1. No user-controlled features are permitted on this system. System is to be active on power up and perform as specified without any form of manual control.

D. Signal Processing Rates

1. System processing rates are real time and occur without interference. Include proper engineering to remove intermodulation effects, interference within system components, echo, delay or disparity reception caused by active or passive components or by the transmission media. System must be capable of supporting a large number of users per frequency.

E. Priority

1. All devices coexist on the system without channel control within the system.

F. Signal Strength

1. Provide minimum signal strength in accordance with NFPA 1221 throughout the coverage areas.

G. Reception

1. Provide complete reception and transmission within the facility without shadows or dead spots.

1.6 QUALITY ASSURANCE

A. Cybersecurity

1. The Risk Management Framework (RMF) is the process by which information systems are accredited for operation by a designated official from the Federal Aviation Administration. It is the standard process under which all FAA information systems must achieve and maintain their Authority to Operate. The Cyber Security process is documented in DOD 8510.01 and NIST SP 800-82. Refer to UFC 4-010-06 for additional requirements.

2. All systems that are IP addressable or interface with the Assured Network must be certified to operate. Coordinate with the Government to initiate and complete the accreditation process.

3. Cybersecurity requires input from the system vendor or provider and support from the local IMD. The local IMD-IA office is the point of contact for all Cybersecurity requirements. The local CMIO is the point of contact for all clinical and functional system requirements.

B. Shop Drawings

1. In exception to Section 013300 SUBMITTAL PROCEDURES, submitted plan drawings must be a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on the wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity. Also include applicable federal, industry, and technical society publication references.

C. Detail Drawings

1. Provide drawings certified by the qualified system integrator. Include drawings specifically prepared to indicate the work for this project. Generic drawings are not acceptable. Submit drawings to include:

   a. System block diagram, riser diagrams, wiring and schematic diagrams, run sheets including number of conductors and wire number (ID), custom assembly details, installation details, location of donor antennae and maps showing donor equipment sites and signal strength at the construction site for each donor system. Provide a drawing that indicates all RF emitting elements, antennae or radiating cable within the system, differentiated from all interconnecting cables and or elements, and the location and value of any non-RF emitting terminations, stubs or loads.
   b. Riser diagrams that indicate the identification number (ID) for all equipment components.
   c. Installation details that indicate layout and mounting of equipment, equipment relationship to other parts of the work, including clearances required for maintenance and operation, and plan and elevation details that indicate the exact and totally coordinated physical location and size of each individual item of equipment.
   d. Installation details for equipment and cabling that is mounted within or on the ceiling, ceiling grid, or hard ceiling structure and that includes the make and model of the surface or recess mounted boxes and wireways, and details for any mounting hardware.
   e. Details for the custom assembly of equipment that indicate the assembly configuration, elevations and dimensions. Typical custom assembly details include equipment panels, and equipment mounted in a rack or cabinet.
   f. Legend of graphic symbols used.

D. Coordination Drawings

1. Submit coordination drawings to include:

a. The details of all electronic and physical interfaces between the DAS System and all interfaced telecommunications systems and other systems, including the exact point and type of demarcation.
b. The layout and mounting of all DAS equipment, and the routing and mounting of cabling in telecommunications rooms and the communications equipment room as coordinated with the layout of all other systems equipment in these rooms.
c. The layout, routing, and mounting details of all equipment, cables and apparatus located in ceilings, passageways, or other areas not indicated as communications spaces, and to coordination of those items with ductwork, plumbing, lighting and other materials so located in those respective areas.

1.7 Qualifications

A. General Qualification Requirements

1. The System Integrator and Installer must each have the minimum qualifications specified, related to the type of system specified for this project. All system components must meet the minimum requirements of this specification.
2. The Government reserves the right to accept or reject the System Integrator or Installer based upon qualifications and ability to conform to specified technical or licensing requirements of this Section. System Integrator, Installers that do not have the specified qualifications will not be accepted.
3. The Government will determine the acceptability of any proposed System Integrator or Installer based on submitted and verified documentation that substantiates that the proposed System Contractor, Installer and Manufacturer have the qualifications specified in this Section.
4. Submit documented verification of the specified qualifications as part of the Data Qualifications submittal. The Government maintains the right to request, inspect and verify references and resumes of all technical and managerial personnel assigned to the project.
5. Include qualification documentation, but not limited to the information outlined below:

a. A list of projects performed by the System Integrator and Installer during the last five years explicitly involving the type of system specified in this section, including:

1) Name of facility where work was completed.
2) Name, title, address and telephone number of a point of contact for the listed facility.
3) The make and model of the system provided and total scope of work for the facility.
4) Restrict list to the facilities where the same type of system was installed for the same purpose provided.

b. An organizational chart of the DAS System Integrator and Installer project team that will perform the work included in this specification section.

c. List and resumes of the principal personnel that will be assigned to the work on this project to include responsibility and relationship to the project management structure. For everyone, include education, certification of factory training, and experience relevant to work assignments for this project. Do not include unrelated experience with other systems. Include the following personnel:

1) System project manager
2) System Application Designer
3) CAD BIM staff that will prepare submittal drawings Installation technician and supervisory personnel
4) Acceptance Testing Personnel
5) Training Personnel

d. Define the work and services that will be performed at locations other than on the project site, and provide points of contact, the address and telephone number of the locations where such off-site work is to be done. Include the following, at a minimum:

1) Project management

a) System application and design and documentation
b) Testing and training plans
c) Repair and maintenance services
d) Maintenance supplies warehouse
e) Training personnel

e. Telephone number that will be answered by staff 24 hours per day, 365 days per year, to obtain repair parts and maintenance service.
f. The System Integrator and Installer qualifications relative to the type of system specified in this Section.
g. A letter from the System Integrator stating that system being provided satisfies all functional and product requirements specified in this Section.
h. A letter from the System Integrator guaranteeing the availability of parts as specified.

6. System Integrator Qualifications

a. System Integrator qualifications must include the following:

1) The System Integrator is regularly engaged in the system application design, documentation, installation, testing, training, and maintenance of the type of system specified in this section.
2) The System Integrator has a minimum of five years' experience providing these services for systems having the same level of features and functions as the system being provided, hold a FCC GROL License, Level III iBwave certified.
3) The System Integrator has a minimum of five years as the manufacturer or an authorized distributor and service organization for the manufacturer of the system provided. b. System Integrator personnel qualifications must:
4) Be factory trained or certified for the make and model of the components used in the system provided.

5) Have a minimum of five years' experience performing the services specified in this specification section.
6) Maintain a full complement of spare parts for the provided system with the ability to furnish on-call maintenance 24 hours per day, 365 days per year.

7. Installer Qualifications

a. The installer personnel must be regularly engaged in the installation of the type of system in this specification section.
b. The installation supervisor must be factory trained and certified or licensed for the type of the system provided.
c. The installation supervisor must have a minimum of five years' experience providing services having the same level of features and functions for the system included in this specification section.
d. The installation personnel must have a minimum of three years' experience providing services having the same level of features and functions for the system included in this specification section.

8. Manufacturer Qualifications

9. The system manufacturer must:
a. Have a minimum of five years' experience in producing the products and type of system included in this specification section.
b. Produce a system that satisfies all specified features, functions and product requirements.
c. Guarantee the availability of the replacement parts for the designed system for a minimum of seven years from the date of final acceptance of the system by the Contracting Officer.
d. Regulatory Requirements

B. PRODUCTS

1. Provide products which comply with FCC Part 15. All products must be able to be networked with the existing ERRC system on the FAA campus.

C. Design and Installation Work

1. Provide design and installation work compliant with FCC Part 95, UL 924, NFPA 70, and TIA-569

D. Electromagnetic Interference (EMI)

1. Comply with FCC EMC and the EMI standards specified in FCC Part 15 for EMI caused by electronics devices.

2. Provide a system that does not generate nor is susceptible to any harmful electromagnetic emission, radiation, or induction that degrades, obstructs, or interrupts the operation of the installed system, any computer system, or life safety system.

3. If any part of the system is certified by the FCC, and subject to CFR technical rules and standards, and are different or in addition to those set forth herein, the standard relating to these parts apply.

4. Comply with current CFR standards that are applicable to the system at the time of system acceptance testing.

5. In the event of a breach of representations or warranties, the System Integrator or Installer, and its own expense, is responsible to put the offending system into compliance with the current applicable CFR standards or replace the offending system with an acceptable system.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protection

1. Store all products delivered and placed in storage protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

2. Delivery Coordination

3. Coordinate deliveries with the Contracting Officer to insure a timely installation.

4. Loss Liability

5. The System Integrator or Installer is liable for any loss due to delivery and storage problems.

6. Delivery Restrictions

   a. Do not deliver products or installation material the project site more than one month prior to commencement of its installation.
   b. System products must not leave the factory prior to six months before the time that the facility is ready for installation of the products. Obtain prior written approval of the shipping date from the Contracting Officer.

7. System Integrator Responsibility the System Integrator or Installer is responsible for all handling and control of products provided under this contract.

1.9 SEQUENCE AND SCHEDULING

A. Install each part of the system and phase into operation as required by the project schedule.

B. Schedule and coordinate work with all other trades and suppliers whose work is critical to the successful installation of the system.

C. Furnish and install all required items for a complete and operating installation to cause no delay in work by others, or completion of the project.

D. Perform final inspection and acceptance testing of each system after the system installation has been completed and all pre-testing, and commissioning have been successfully completed.

1.10 WARRANTY

A. Provide equipment items that are supported by service organizations which are reasonably convenient to the equipment installation to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Warranty the operational and physical integrity of the provided system, including a warranty against all defects in design, equipment, materials, software, workmanship, and improper installation and adjustments, for a period of at least one year from the date of final acceptance of the work. If the System Integrator or Manufacturer warranty is for a period longer than one year, the longest warranty period governs. Include a warranty document with the Product Data submittal.

C. During the warranty period any maintenance, adjustments or repairs in accordance with the Warranty Maintenance specifications herein. Warranty repair of minor malfunctions desired by the Government at other than normal working hours may be charged at current labor rates for the premium portion of time.

1.11 MAINTENANCE

A. Operation and Maintenance Manuals

1. Furnished commercial off the shelf manuals for operation, installation, configuration, and maintenance of products. Submit operations and maintenance data in accordance with Section 017823 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs DETAIL DRAWINGS, and COORDINATION DRAWINGS. Ensure that these drawings and documents depict the as-built configuration.

B. Extra Materials

1. Off-The-Shelf Maintenance Parts

2. Provide guarantee that a stock of the subsystem component parts required for maintenance service will be available off-the-shelf from the system integrator and can be express shipped to the Facility if not available locally within a 150 mile driving radius of the Facility. Parts that must be ordered from the Manufacturer for the repair of a major malfunction, as defined herein, must be express shipped for delivery within one day after the major malfunction has been identified. Parts that must be ordered from the Manufacturer for the repair of a minor malfunction, as defined herein, must be express shipped for delivery two days after the minor malfunction has been identified.

3. Installation Spare Parts

4. The System Integrator is required to keep an adequate quantity of installation spare parts onsite to preclude work stoppages and to meet other contingencies that might arise prior to the final inspection and acceptance of the system.

5. Post Acceptance Spare Parts

   a. After the system has been in acceptance by the Government, recommend and provide one of the minimum quantity and type of onsite spare parts as necessary to maintain the full operation of the system in case of failure.
   b. System Integrator is required to maintain spare parts on-site during the warranty period to facilitate quick repair through plug-in module replacement of key system components, then replenished and turned over to the Government at the end of warranty period.
   c. Provide recommendation of any additional onsite spare parts deemed necessary by the Manufacturer and or the System Integrator. Furnish to the Contracting Officer the cost of recommended additional spare components as a separate line item.

6. Special Tools and Equipment

7. Provide any special maintenance tools, equipment and software are defined as those items that are uniquely required, due to Manufacturer make or model of the provided products, to install, setup, initialize, program, and maintain any component or function of the system such. Provide, after final inspection and acceptance, one set of any special tools, equipment and software necessary.

8. Maintenance Service

   a. Perform warranty maintenance service on the system using qualified maintenance personnel that have been trained for the system being serviced.
   b. System Integrator is required to offer a Service Agreement to the facility. Include a copy of the proposed Service Agreement with the Product Data Submittal.
   c. As authorized by the facility, the contractor may utilize facility maintenance personnel that have been factory trained for maintenance of the provided system for the first level of response to a call for service.
   d. If available at the project location, provide and on-line diagnostic maintenance support capability as specified herein.

9. Service Availability and Response Time

   a. Provide maintenance service on a 24 hour per day, 7 days per week, 365 days per year basis for on-premises maintenance within 8 hours after notification of a major malfunction. Maintenance service must include a 24-hour answering service available to receive after hour maintenance requests and to dispatch on-call service personnel within the required response time.
   b. All major repair malfunctions must be accomplished within 8 hours of the reported failure. A major malfunction is defined as failure of one of the following major functional components:

      1) Complete failure of any headend or remote equipment.
      2) Failure of a power supply, exclusive of loss of utility power feed.
      3) Failure of 20 percent or more of all antenna locations in the facility.

c. Repair of a minor malfunction is any failure other than a major malfunction. Minor malfunctions must be repaired within 48 hours.

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT

A. New Products

1. Provide products, components, and devices that are new and free of defects. Coordinate floor space requirements and electrical branch circuits for all equipment requiring 120 VAC. Any special cabinetry or shielded enclosures are the responsibility of the System Integrator or Installer and are to be provided and installed as part of this system.

B. Unspecified Products

1. If the provided system requires additional products that are not specified or indicated on the Telecommunications Drawings to satisfy the specified performance requirements for the system, then provide additional component.

C. Product Modifications

1. Modification of products that nullifies the UL listing or other agency approval is not permitted.

D. Identical Products

1. Provide identical make and model for products such as component equipment, modules, assemblies, parts and materials of the same classification.

E. Nameplates and Equipment Markings

1. Provide nameplate and equipment marking for each major equipment component to include the Manufacturer's name, model, and serial number on a plate secured to the equipment. Also, include all compliance with regulatory requirements, such as UL and CFR on the nameplate or on adjacent labels.

2. Plainly and permanently label all controls with the identification of the function served. Stick on marker tapes are not acceptable.

F. Mounting Alignment Capability

1. Provide wall mounted components with capability for adjustable mounting alignment to compensate for improperly aligned back boxes and to insure a plumb, square, and level installation.

G. Model and Enhancements

1. Provide products and components that are the manufacturer's latest model, design, version, and quality in production at time of delivery and installation.

2. Notify the Contracting Officer of any product enhancements that become available after delivery and installation, and up to time of system acceptance, must be brought to the attention of the Contracting Officer upon announcement by the Manufacturer and make enhancements available to the Government. If such enhancements customarily are provided at no additional cost, the Government must automatically be entitled to such enhancements. If such enhancements customarily are provided at additional cost, the Contracting Officer may choose to accept or reject such enhancements.

3. Submit a letter to the Contracting Officer from the Manufacturer guaranteeing that the Manufacturer will inform the Government of, and make available to the Government, all commercially available enhancements to the System at the then current price. Include the letter with the Data Submittal.

4. Substitutions, modifications, or improvements to a System are permissible provided that such substitution, modifications, or improvements will not reduce or degrade the performance or product requirements, nor violate regulatory requirements. No such substitutions, modifications, or improvements can be made without the written consent of the Manufacturer and Contracting Officer. Such consent must not be unreasonably withheld or delayed.

H. Software and License

1. Issue to the Government a nonexclusive, fully paid perpetual license to use the software provided.

2. Provide software maintenance that is offered to all other customers without charge to the Government without charge.

2.2 BIDIRECTIONAL AMPLIFIERS

A. The primary bidirectional amplifiers will be in the equipment room.

B. Locate Any additional amplifiers required by the System Application Design in telecommunications rooms or electrical rooms.

2.3 ACTIVE AND PASSIVE EQUIPMENT

A. Locate all active equipment in equipment room, electrical room or telecommunications room as may be required by system application design. Coordinate all mounting locations with the Contracting Officer. Provide all mounting materials as part of this system. Install any passive or other components, excluding coaxial cables and antenna, that are installed in the facility at locations other than the telecommunications rooms or equipment rooms in locked steel cabinets, keyed alike and provided and installed as part of this system.

2.4 ENCLOSURES

1. Provide NEMA Type 12 enclosures in interior spaces such as clean, dry environments. Provide NEMA Type 4X for enclosures located outdoors.

2.5 OPERATING FREQUENCIES

A. All RF emitting devices used must be certified by the radio licensing authority to achieve the required radio coverage. Any frequencies for which the facility does not have a license to retransmit must not be amplified nor retransmitted. All RF emitting devices must have the certification of the radio licensing authority and be suitable for public safety use prior to installation in accordance with NFPA 1221.

1. Provide capability to process required communications signals from outside the facility to include transmitted frequencies of:

   a. FAA Band First Responder Trunked Radio Frequencies
   b. Coordinate any additional frequencies with the contracting officer.
   c. Receive and transmit frequencies for military and public EMS. Re-transmit frequencies unaltered. Coordinate frequencies with the installation frequency manager via the Contracting Officer.

2.6 TRANSMISSION LINE

A. Provide all required cables and associated passive components in accordance with the system application design. Provide plenum rated feeder and riser cables in accordance with NFPA 1221 that meet all performance requirements, fire and environmental regulations as installed by the specific design for this project.

2.7 DONOR ANTENNAS

A. Provide antenna networking that conform to TIA-329.1-D. Engineer the antenna network to the proper system performance for the TIA-455-13 operating frequencies indicated in this specification.

B. Provide all required cables in accordance with the system application design and engineered to the correct performance of the system.

C. Antennas must not interfere with any other system in accordance with this specification. The HQB system will be networked via fiber with the existing donor antenna on the FAA’S MMAC Multi-Purpose Building (MPB).

D. Provide lightning protection and equipment for separate grounding of the antenna mast as required by NFPA 780.

E. Provide isolation between donor antenna and all inside antennas to a minimum of 20dB under all operating conditions in accordance with NFPA 1221.

2.8 PORTABLE EQUIPMENT

A. No portable receivers, transmitters, or radio devices are to be provided as part of this system.

2.9 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Volt-Amp capacity must be at least 130 percent of the total volt-amp load of the equipment connected to the UPS. UPS must provide of runtime required by NFPA 1221 under the highest system load possible. Include power requirement calculations with design data submittal to verify power requirements.

B. Upon an ac power line outage, the UPS must automatically transfer to battery power within 4.2 milliseconds of sensing ac power line loss and provide at least 15 minutes of full power for operation of the equipment connected to the UPS. On-battery output voltage must be 115 VAC, plus or minus 5 percent.

C. The UPS must use sealed, maintenance free type batteries that have an expected life of at least three years. Power batteries from a constant voltage or "float type" battery charger. Recharge time to 90 percent capacity after discharge to 50 percent capacity must not exceed 10 hours.

D. Surge energy rating must be at least 320 joules. Surge peak current capability must be at least 26 ka.

E. UPS visual indicators on the UPS front panel must indicate on-line operation, output overload, low battery, and replace battery. Provide network reporting of UPS functions and warnings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Perform a site survey to verify all field conditions, become familiar with the details of the work and working conditions, verify dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 BUILDING UTILITY AND SUPPORT

A. Locate equipment and connect to branch circuits and grounding system and utilize pathways as indicated on the drawings. Where additional space, branch circuiting, grounding, or pathways are necessary to support the system as designed, notify the Contracting Officer of additional support needed.

3.3 PREPARATIONS

A. As part of the project planning and system application design, and prior to the submittal of documents and plans, gather the data required to design and install the system, and plan the work. Include the data listed below, at a minimum.

1. User Room Numbers and Names

2. Obtain from the Contracting Officer a listing of facility User room numbers and room names cross referenced to the architectural room numbers and names indicated on the contract documents. Use the facility User room numbers and room names for all system functions, applications software, and as-built documentation.

3. Interfaces and Interconnections

   a. Coordinate and define the details of all interfaces and interconnections with other systems and equipment as specified herein. Include a detailed definition of all electronic and physical interface requirements, interface protocols, and physical demarcation points, donor frequencies, donor signal levels and injection levels for directly coupled systems. Provide details as part of Drawings and Data submittals.
   b. Include the following interfaces and connections:

      1) First Responder Trunked Radio Certificates and Authorizations
      2) Provide certificate of authority and/or operational authority from the licensee of all individual services utilizing this System. Include the FCC station identification information, details of frequency, power, and modulation, and a specific authority to operate a distribution and/or rebroadcast system on said frequency at the project location, any restrictions in operating conditions, levels, emissions or other conditions, and issued in the name of the facility with a point of contact at the Licensee.

3.4 INSTALLATION

A. General

1. Provide installation as indicated and specified, and in accordance with acknowledged industry and professional standards and practices, and the Manufacturer's instructions.

2. Comply with the requirements of NFPA 70, NFPA 72, NFPA 1221, and TIA-569.

3. Only the Installer as qualified in Paragraph QUALITY ASSURANCE, subparagraph Installer Qualifications, is permitted install and connect all equipment and system cabling.

4. Maintain onsite a supervisor during the entire installation as qualified in Paragraph QUALITY ASSURANCE, subparagraph Installer Qualifications.

5. Provide all tools and equipment needed to install the system.

B. Equipment Installation

1. Provide appropriate waterproof gaskets for equipment installations in exposed areas.

2. Locate equipment where indicated on the drawings or where indicated in this specification section. Mounting of system components in any room other than a Comm Room or above finished ceilings is not acceptable without written authorization by the Contracting Officer.

3. Rack mount system components. Floor mounted equipment is prohibited.

4. Install equipment firmly secured in place, plumb, square, and level.

5. Provide adequate equipment ventilation and adequate equipment accessibility for service and repair. DAS equipment shall be installed in spaces where ambient conditions are between 60-80 degrees F.

C. System Cabling Installation

1. Install system cabling using the approved qualified installer in accordance with NFPA 70. Install cables without kinks, sharp bends or deformations or abrasions as recommended by the cable manufacturer. Install cable in cable trays, conduits, and boxes as indicated. Coordinate the system cable routing with other cable routing of other systems to ensure that there will be no interference that will adversely affect the performance of this system of any other specified or GFGI system. The System Integrator is responsible to notify the Contracting Officer of any routing conflicts prior to placement of cable. Provide firestopping where penetrations are required in rated floors, walls, or ceilings in accordance with Section 078400 FIRESTOPPING, by approved firestop installer.

D. Grounding

1. Ground equipment enclosures and all other non-current carrying exposed metal parts of electric equipment.

3.5 AC POWER CONNECTIONS

A. AC power for all equipment must be circuited to the electrical system, emergency system, life safety branch in accordance with NFPA 70 and NFPA 72.

B. Connect the system to the essential electrical system life safety branch as indicated on the drawings. The System Integrator is responsible for coordinating that the active system components are provided with required branch circuits. The System Integrator is responsible coordinating any other power requirements to active devices with the Contracting Officer as necessary where adequate circuits are not indicated on the contract drawings.

3.6 TRANSMISSION LINE

A. Install transmission line(s) to the roof in the indicated pathway, with the outer conductor and lighting arrestor grounded to the indicated grounding system in accordance with NFPA 70 and NFPA 780. Provide any additional grounding required.

3.7 INSTALLATION SETUP

A. Make all adjustments as necessary to setup the system to function in accordance with specific user requirements for the overall system.

3.8 FIELD QUALITY CONTROL

A. Inspection, Testing and Validation

1. Prepare and submit an Acceptance Test Plan that includes the requirements of this Section. Include step-by-step procedures and the expected results to demonstrate system compliance with the requirements of this specification. Include tests defined in the Manufacturer's installation instructions; list of all test equipment to be used, including data indicating that calibration of the test equipment is current; test data sheets; and names and qualifications of the person(s) who will perform the tests. Coordinate the Test Plan with the Commissioning Plan.

2. Furnish required test equipment, tools, consumable supplies, and technically qualified and licensed personnel to perform inspections, testing and validation of the installed system. All test equipment must be in current calibration and must have a current calibration certification.

3. The Contracting Officer reserves the right to approve the System Contractor's choice of testing personnel, and, upon rejection of any testing personnel by the Contracting Officer at any time, the System Contractor is required to replace such testing personnel as soon as reasonably possible. Upon request, provide the Contracting Officer the opportunity to review the qualifications of each person proposed for testing work.

4. Conduct all inspections and testing in accordance with submitted and approved quality control, testing [and commissioning plans] and procedure, and requirements specified herein.

5. Notify Contracting Officer at least 30 days prior of any planned inspection and testing, but in no case prior the System Integrator having received written Government approval of the submitted test plans, including procedures.

6. Conduct inspection and testing during normal working hours with prior notice to the Contracting Officer so as not to interfere with orderly work processes.

7. Allow inspection by the Contracting Officer of all work and workmanship, and witnessing of System Integrator performed inspections, system readiness checks, integrated performance testing, and acceptance testing.

8. Expose any work that is enclosed or concealed before being inspected and tested and restore to the original condition after inspection and testing.

9. Submit results of each inspection and test in electronic and hard copy format to the Contracting Officer.

B. Periodic Inspection and Testing

1. The Contracting Officer reserves the right to always inspect and test all work and workmanship during preparation and installation. The Contracting Officer, in his or her sole discretion, may reject defective work and workmanship and require its correction. The Government right to inspect, test, and reject, or its failure to exercise such right, as provided herein, must in no way diminish the System Integrator's duty to inspect and reject work as necessary to comply fully with the requirements of the contract documents.

2. Licensees who have granted permissions are responsible for their frequencies operating within their license. Licensees are responsible for inspections for their operating signals and have the right to revoke permissions at any time.

C. System Readiness Checks

1. Place the system into complete working order in full compliance with specified requirements, system application design, and all setup requirements, including requirements listed in the Licensee's Authority to the Facility, programming and adjustments prior to the start of system testing and validation. Perform system readiness checks to certify that the system is ready for testing and validation.

D. Integrated Performance Testing

1. Perform all necessary performance testing of interoperability of the telecommunications systems with each other, and with other building systems. Such testing is to demonstrate full integration and/or interface of systems and to demonstrate they function as a comprehensive system where necessary.

E. Final Inspection and Acceptance Testing

1. General Requirements

a. After installation has been completed, and system readiness checks and integrated performance testing have been successfully completed, notify the Contracting Officer that the system is ready for final inspection and acceptance testing. Conduct final inspection and acceptance tests in accordance with the approved Test Plan [and Commissioning Plan], and the project schedule.
b. Draft as-built system drawings and operating and maintenance manuals must be made available by the System Integrator for use during performance of final inspection and acceptance testing. Final inspection or acceptance testing will not be scheduled nor performed without this documentation.
c. Upon successful completion of final acceptance tests, and 30 calendar days of consecutive operation in accordance with specified requirements without the occurrence of any major malfunctions, submit the final acceptance test report, including certificates of compliance and certificate(s) of Licensee Authority with Licensee inspection report stating that all specified requirements and conditions have been satisfied. The effective date for completion of the final system acceptance will be the date when the system has satisfied the 30 days of operation without a major malfunction as specified above.

F. Acceptance Test Procedure

1. Provide final acceptance tests that demonstrate that the system operates in full accordance with all specified requirements, system application design, and user setup requirements for the system. Demonstrate that each system operating mode performs as required by operation of each individual system component under normal or simulated normal system conditions.

2. Include the following tests, at a minimum:

   a. Operation under AC power failure conditions. Include demonstration of UPS capability under normal power loading conditions, and operation under emergency power conditions.
   b. Signal quality under worst-case loading conditions of low voltage power supplies.
   c. Operation of electronic supervision circuitry.
   d. Operation of 100 percent of all components.
   e. All interface functions.
   f. Place and test devices from inside the facility to other mobile devices within the facility. Place and test devices from inside the facility to other mobile devices outside the facility. Place and test other devices from outside the facility to other mobile devices inside the facility. Perform each inside/outside test a minimum of ten times from various points selected by the Contracting Officer to demonstrate complete coverage throughout the facility.
   g. A test will be considered as passed if the device successfully connects and message is transferred without error. A pass rate of 100 percent is required.
   h. Sweep test all coaxial cables for all frequencies the system can transmit whether or not in service.

3. Include testing equipment for frequency and signal strength testing.

G. Corrective Action for Rejected Work

1. Correct all deficiencies and another re-test as necessary to demonstrate compliance with all requirements to the Contracting Officer.

2. Complete all corrective action within a reasonable time consistent with project schedules and acceptable to the Contracting Officer.

3. If, after 30 calendar days from the start of acceptance testing, the system or any equipment component thereof fails to demonstrate complete and proper performance, the Government reserves the right to return the total system or any equipment component to the System Integrator. The System Integrator is required refund all costs thereof to the Government and to indemnify the Government from damages, costs, and expenses incurred in connection with such activity.

4. The Government retains absolute control of the actual date of return of any rejected system or equipment component. The Government reserves the right to continue to utilize such system and equipment until the actual date of removal.

H. Acceptance Test Report

1. Provide test reports in booklet form with witness signatures verifying execution of tests. Include physical routing and a test report for each cable from the installed outlet to the main termination point. Submit test report within 14 days after completion of the testing.

I. Warranty Period Inspection and Testing

1. Observe the system in operation at the end of the 4th and 9th months after the time of acceptance and re-conduct acceptance tests to demonstrate that system is continuing to perform as specified. Coordinate with the Contracting Officer. The Contracting Officer and a Customer Representative reserve the right to participate in this activity. Include interviews of users to determine if the system is satisfying specified requirements and that training is adequate. Provide written report of results to the Contracting Officer. During the 11th month of operation, re-inspect and retest the system to identify and correct any deficiencies prior to the end of the warranty period. A facility Government representative reserves the right to witness this procedure. Make all correction actions necessary. Provide written report of results to the Contracting Officer.

3.9 CLOSEOUT ACTIVITIES

A. Training Plan

1. Develop and submit a Training Plan for approval by the Contracting Officer. The training plan must describe the training to be provided. The Training Plan must include, but not be limited to the following items: (1) Describe the operation and maintenance training programs, and instructional materials to be provided.

    a. As coordinated with the user, define the number of staff members that will be expected to attend each training session, and the classrooms to be used for on-site training.
    b. Furnish the identity and qualification of training instructors, and the instructional schedules for all classes.
    c. Provide training to the Facility staff in accordance with the approved Training Plan.

2. General Preparations

3. During the week prior to the start of training for any system, check the system to assure that it has been successfully commissioned and acceptance tested, and is in full-specified operation condition.

4. Training Personnel

    a. Furnish qualified factory trained or certified instructors to train designated Facility staff in the operation and maintenance of the provided system.
    b. The Contracting Officer reserves the right to approve the System Integrator's choice of training personnel, and, upon rejection of a trainer by the Contracting Officer at any time, the System Integrator must immediately replace such trainers. Upon request, the System Integrator will provide the Contracting Officer the opportunity to review the qualifications of each proposed trainer.

5. Training Instructions

   a. Include all specified performance and capabilities of the system in the training instructions, and all the items contained in the operation and maintenance manuals. In addition, include preventive maintenance, routine maintenance, repair and troubleshooting procedures.

6. Training Materials and Recordings

   a. Furnish all training materials and handouts. Provide the quantity needed for all the Facility maintenance technicians, operations and user staff that will receive training. Provide Six copies of all standard training media, such as video recordings, CDs and DVDs that are available from the Manufacturer to the Contracting Officer.

7. Onsite Training Programs and Requirements

   a. Provided all training on site to all Facility staff as required throughout the contract and warranty period to train operations and maintenance staff for the provided system. Include two training courses, one for maintenance technicians, and one for user and operations staff. Include classroom training and field training. Field training for Facility staff will take place in the area where the staff will be working. Coordinate classroom training with the Contracting Officer. Conduct multiple instructional units for each onsite course on a three shift, seven days a week basis as required to train all staff during their normal on-duty working hours. The Contracting Officer will designate qualified personnel to be instructed in the operation and maintenance of each system, schedule instructional sessions, and provide suitable onsite instruction facilities.

8. User and Operational Staff Training

   a. Comments user and operational staff training at a time acceptable to the Contracting Officer and near the time the system is scheduled for operational use by the Facility staff. Provide classroom instructions for all Major Functional Components of the system, and field instructions in each area where equipment is installed. Nine months after the system is installed and accepted by the Government, provide refresher coerce to the user and operational staff.

9. Technician Training

   a. Before the system is turned over to the Government for operational use, provide training for maintenance technicians designated by the Contracting Officer. Provide the number of instructional hours necessary to cover all aspects of system setup, programming, operations, preventive maintenance, routine maintenance, routine repair, and troubleshooting procedures for the system as installed. Nine months after the system is installed and accepted by the Contracting Officer, provide a comprehensive refresher course covering the final configuration for the system. Provide technician training on site and focus on failure diagnosis and field repair.

10. PROTECTION

a. Do not permanently install items that can be easily stolen, such as desktop computer and monitor equipment, until such time as the System Integrator has been notified by the Contracting Officer that the facility is secured.

11. CLOSEOUT DOCUMENTATION

a. Prepare and submit all documents as required.
b. Maintain a record of all maintenance and repair, including subsequent field strength readings, performed during the warranty period and submit the record at the end of the warranty period.

-- End of Section --

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire alarm control unit.
2. Manual fire alarm boxes.
3. System smoke detectors.
4. Addressable notification appliances.
5. Device guards.
6. Magnetic door holders.
7. Remote annunciator.
8. Addressable interface device.
9. Fiber Interface.
10. Network communications.

B. Related Requirements:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire alarm systems.

C. Comply with phasing plan.

1.2 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACU: Fire Alarm Control Unit.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire alarm system.

1. Submit to Architect/Engineer and Commissioning Authority before submitting to Authorities Having Jurisdiction for review.

2. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
3. Include plans, elevations, sections, details, and attachments to other work.
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
5. Detail assembly and support requirements.
6. Include voltage drop calculations for notification-appliance circuits.
7. Include battery size calculations.
8. Include input/output matrix.
9. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
10. Include performance parameters and installation details for each detector.
11. Verify that each duct smoke detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Locate detectors according to manufacturer's written recommendations.

13. Include single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address and legend of each addressable device. Show size and route conduits and point-to-point wiring diagrams.
15. Include point list with addresses, devices, legends.

C. General Submittal Requirements:

1. Submittals shall be approved by Architect/Engineer before submitting them to authorities having jurisdiction .
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire alarm system design.
    b. NICET-certified, fire alarm technician; Level III minimum.
    c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: The fire alarm system is a delegated design. For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer or signed by the NICET Technician responsible for their preparation.

1. Drawings showing the location of each notification appliance, smoke and heat detector, and other input/output device, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Fire alarm installer shall be a fire alarm technician licensed by the State of Oklahoma. Demolition and installation of fire alarm equipment, devices, wiring, terminations and programming shall be performed by a fire alarm technician.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documentation" Article in the "Documentation" chapter in NFPA 72.
   c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
   d. Riser diagram.
   e. Device addresses on point list with legends, device types.
   f. Record copy of site-specific software.
   g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

      1) Equipment tested.
      2) Frequency of testing of installed components.
      3) Frequency of inspection of installed components.
      4) Requirements and recommendations related to results of maintenance.
      5) Manufacturer's user training manuals.

   h. Manufacturer's required maintenance related to system warranty requirements.
   i. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB drive or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Fire alarm demolition and installation shall be performed by a fire alarm technician.

1.8 PROJECT CONDITIONS

A. Perform a full inspection of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire Alarm Service: DO NOT interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Architect and Owner no fewer than fourteen days in advance of proposed interruption of fire alarm service.
2. Do not proceed with interruption of fire alarm service without Architect's and Owner's written permission.
3. Notify the AHJ when a system is out of service per IFC requirements.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Coordinate Maintaining existing equipment fully operational with fire watch in any unprotected areas until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building. In the case of a portion of a system not in service at a panel location, identify which portions of the system are in service, and which are not in service.

B. Coordinate with Owner at least 14 days before fire alarm service is interrupted. Minimize interruption duration. Owner will provide fire watch during interruption of service.

C. Equipment Removal: After acceptance of new fire alarm system, remove existing disconnected fire alarm equipment and wiring. Fire alarm system demolition shall be performed by a fire alarm technician.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: One year from date of Substantial Completion, or system acceptance, whichever is later.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing Simplex system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. 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.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Move duct smoke detectors to. (Supervisory)Remove if not provided.
5. Automatic sprinkler system water flow.
6. Preaction system. (monitoring of existing systems)
7. Fire extinguishing system operation.
8. Preaction or Dry pipe system pressure waterflow pressure switch.
9. As shown on the system matrix.

B. Fire alarm signal shall initiate the following actions, as applicable:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Release fire and smoke doors held open by magnetic door holders.
5. Close smoke dampers in air ducts of designated air-conditioning duct systems.
6. Recall elevators to primary or alternate recall floors.
7. Activate elevator power shunt trip.
8. Activate emergency lighting control.
9. Record events in the system memory.
10. Indicate device in alarm on the annunciators.
11. As shown on the system matrix.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Duct smoke detectors
4. Elevator shunt-trip supervision.
5. Generator monitoring
6. Independent fire detection and suppression systems.
7. User disabling of zones or individual devices.
8. Loss of communication with any panel on the network.
9. As shown on the system matrix.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire alarm control unit.
5. Ground or a single break in internal circuits of fire alarm control unit.
6. Abnormal ac voltage at fire alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire alarm control unit or annunciator.
10. As shown on the system matrix.

E. System Supervisory Signal Actions:

1. Initiate notification appliances such as common and audible.
2. Identify specific device initiating the event at fire alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.
5. Display system status on graphic annunciator.

2.3 FIRE ALARM CONTROL UNIT

A. General Requirements for Fire Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864, fully compatible with the main SimplexGrinnell Fire Alarm panel in the Administration Building.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACU and remote circuit interface panels, annunciators, and displays.
    d. The FACU shall be listed for connection via fiber interface to the main FACU.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACU shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACU shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACU shall be listed for releasing service and shall support the use of addressable notification devices.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, two lines of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.

2. Pathway Survivability: Level 1.
3. Install no more than 100 addressable devices on each signaling-line circuit.
4. Serial Interfaces:

    a. One dedicated RS 485 port for central-station remote station operation using point ID DACT.
    b. One (minimum) RS 485 port for remote textual and graphic annunciators, Ethernet module, or multi-interface module (printer port).
    c. One USB port for PC configuration.

D. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
3. Systems shall have the capability of supporting addressable notification devices.

E. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

    a. Elevator lobby detectors except the lobby detector on the designated floor shall return to the alternate floor.
    b. Smoke detector in elevator machine room.
    c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room or a heat detector shall shut down elevators associated with the location without time delay.
4. Heat detector in elevator hoistway or machine room shall shunt trip the elevator. Shunt circuit shall be supervised.

F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire alarm system.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station via fiber loop to Trusite Workstation.

I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

K. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE ALARM BOXES

A. General Requirements for Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire alarm control unit.

    a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire alarm control unit for 15 or 20 deg F per minute.
    b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire alarm control unit to operate at 135 or 155 deg F.
    c. Multiple levels of detection sensitivity for each sensor.
    d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
7. Detector shall be listed for velocity down to 100 feet per minute.
8. Provide LED indicators and key switches for duct smoke detectors above 7’-0.

2.6 NONSYSTEM SMOKE DETECTORS

A. General Requirements for Nonsystem Smoke Detectors:

1. Nonsystem smoke detectors shall be listed as compatible with the fire alarm equipment installed or shall have a contact closure interface listed for the connected load.
2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

2.7 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

B. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 F.

2.8 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

1. Rated Light Output:

a. 135 cd, 177 cd.
b. 15/30/75/110 cd, selectable in the field.

2. Mounting: Ceiling mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, white.

2.9 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.10 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.11 GRAPHIC MAP

A. Mounted in an aluminum frame with nonglare, minimum 3/16" thick clear acrylic cover over graphic representation of the facility.

B. Graphic representation of the facility shall be a CAD drawing, CAD drawing shall be at least 1/16 inch per foot scale, and include all floors.

C. Include north arrow, "YOU ARE HERE" locator, fire alarm and suppression control panel locations, fire sprinkler zone boundaries, FDC location.

2.12 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown Insert functions.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.
3. As shown on the system matrix.

2.13 FIBER INTERFACE

A. Fiber Optic Transceiver shall interface with the FACU and shall provide two-way communication with the Headquarters Building over the single mode fiber-optic cable.

2.14 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Programming device.
2. LED display.
3. Manual test report function and manual transmission clear indication.

C. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.
9. Insert signal to be transmitted.

2.15 NETWORK COMMUNICATIONS

A. Provide network communications for fire alarm system according to Owner's and fire alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

2.16 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.

1. Remove existing FACU and equipment then install new FACU and equipment throughout entirety of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

D. Manual Fire Alarm Boxes:

1. Install manual fire alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire alarm box on a background of a contrasting color.
3. The operable part of manual fire alarm box shall be between 42 inches and 45 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

E. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Spacing of detectors shall be determined according to NFPA 72.
4. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
5. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
6. Provide ceiling mounted spot smoke detectors in all areas with ceiling plenums or where fan powered VAV boxes recirculate air common to more than one unit. Detector locations shall be approved by Architect/Engineer and Owner.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

H. Audible Alarm-Indicating Devices: Install wall mounted devices not less than 6 inches below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated. Lay-in ceiling mounted devices shall be mounted center of tile.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways shall be installed in EMT or metallic conduit. Conduit, EMT and junction boxes shall be red.

3.4 CONNECTIONS

A. For fire protection systems related to doors in fire rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087111 "Door Hardware." Connect hardware and devices to fire alarm system.

1. Verify that hardware and devices are listed for use with installed fire alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at elevator shunt-trip breaker.
7. Data communication circuits for connection to building management system.
8. As shown on system matrix.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire alarm control unit.

3.6 GROUNDING

A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

C. Provide surge suppression exterior to each panel on incoming 120 V power, grounded per surge suppressor manufacturer's instructions.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative in the presence of Architect/Engineer and Commissioning Agent before inspection by AHJ. Submit test plan and procedures with test personnel and agenda per the ITM chapter of NFPA 72 a minimum 14 days in advance of proposed commissioning date:

1. Visual Inspection: Conduct visual inspection prior to testing.

   a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Delivery section" table in the "Documentation" “Record of Completion" chapter in NFPA 72.
   b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Documentation" chapter in NFPA 72.

B. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of reprogrammed, added or replaced devices and appliances. Update certificates, graphic annunciator and record drawings with any modifications.

C. Fire alarm system will be considered defective if it does not pass tests and inspections.

D. Prepare test, submit documentation, and inspection reports.

3.8 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire alarm system.

END OF SECTION

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Driveways.
2. Parking lots.
3. Curbs and gutters.
4. Walks.

B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete " for general building applications of concrete.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.3 SUBMITTALS

A. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

B. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

C. ACI Publications: Comply with ACI 301 unless otherwise indicated.

D. 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 full-thickness sections of concrete paving to demonstrate typical joints; surface finish, and color; curing; and standard of workmanship.

1.5 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

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

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

C. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

D. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

E. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

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

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

G. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIALS

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

1. Portland Cement: ASTM C 150, gray portland cement Type I/II .

B. Normal-Weight Aggregates: ASTM C 33, Class 4M, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2.4 CURING MATERIALS

A. Water: Potable.

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

2.5 RELATED MATERIALS

A. Pigmented Mineral Dry-Shake 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, provide one of the following Bomanite, Color Hardener:

   a. Scofield, L. M. Company; LITHOCHROME Color Hardener.
   b. Stampcrete International, Ltd.; Color Hardener.

2. Color: .

   a. Type A Bomanite Shale Gray
   b. Type B Bomanite Coal Gray

2.6 PAVEMENT MARKINGS

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type S; colors complying with FS TT-P-1952.

1. Color: As indicated.

B. Provide a minimum two (2) year warranty on pavement markings from date of completion.

C. Glass Beads: AASHTO M 247, Type 1.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties as indicated on the drawings:

1. Compressive Strength (28 Days): 4000 psi.
2. Flexural Strength (28 Days): 650 psi.
3. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45 .
4. Slump Limit: 5 inches, plus or minus 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 as follows:

1. Air Content: 4-1/2 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

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

1. Use water-reducing admixture in concrete as required for placement and workability.

F. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

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 concrete batches of 1 cu. yd. 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 concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.

2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

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

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Provide tie bars at sides of paving strips where indicated.

2. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

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

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft., unless greater amount is recommended by manufacturer to match paving color required.
2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
3. After final power floating, apply a hand-trowel finish followed by a broom finish.
4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by curing compound as follows:

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

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Lateral Alignment and Spacing of Dowels: 1 inch.
5. Vertical Alignment of Dowels: 1/4 inch.
6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
7. Joint Spacing: 3 inches.
8. Contraction Joint Depth: Plus 1/4 inch, no minus.
9. Joint Width: Plus 1/8 inch, no minus.

3.11 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal..

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: 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 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

a. When frequency of testing will provide fewer than five compressive-strength or flexural-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, pressure method; 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 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Flexural Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard beam specimens for each composite sample.
7. Flexural-Strength Tests: ASTM C78 C 78M; test one specimen at 28 days and two specimens at 90 days.
8. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

C. Strength of each concrete mixture will be satisfactory if 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 500 psi, or if average of any three consecutive flexural-strength tests equals or exceeds specified flexural strength and no flexural-strength test value falls below specified flexural strength by more than 50.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 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, 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. Reports of flexural-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design flexural strength at 90 days, concrete mixture proportions and materials, flexural breaking strength, and type of break for both 28- and 90-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. 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 Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

E. Maintain pavement markings free of wearing, fading, peeling, or other damage until substantial completion of the project. Repair or replace pavement markings that are damaged or defective.

END OF SECTION

SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.

B. Related Sections:

1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.2 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

1.4 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: Sealants are to match the color of concrete that is adjacent to the joint. When sealant is between one side of colored concrete and one side of uncolored concrete, match the uncolored concrete. When sealant is between two sections of colored concrete of different colors, match the darker color.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

2.3 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.4 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place joint sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 321716 - PARKING CONTROLS (Addendum #2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Industrial Barrier Arm Operator
2. Card Reader Pedestal

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 INDUSTRIAL BARRIER ARM OPERATOR

A. Duty Cycle: 2,000 cycles a day.

B. Drive: Hydraulic

C. Finish: Zinc Plated with yellow powder coating

D. Full 90 degree open.

E. Open/Close Time: 2 seconds to open, 3 seconds to close

F. Arm Length: 14 feet

G. Arm Design: Side Mount, lighted aluminum oval design with bumper and lights, breakaway arm mount and kill switch

H. Power: Single Phase 115/208/230V, 60Hz, 110/220V 50 Hz, 3/4 HP

I. Communication: Interconnect with Building Security System and adjacent Card Reader.

J. User Controls: Manufacturers Standard Controller with touch keypad and display

K. Relays: Three configurable user relays

1. (1) 30VDC, 3A solid State
2. (2) 250VAC, 10A electromechanical

L. Listed to UL 325: Usage Class I, II, III, IV.

M. Backup Power: AC Power Supply

N. Warranty: 5-year

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are limited to the following Basis of Design Manufacturer:

1. HySecurity: StrongArm 14F (Part #HTG 320-2 ST)

2.3 CARD READER PEDESTAL

A. Install 1 1/2" diameter, 3'-6" in height, steel (Sch 40) pipe with welded cap at the top. The Pedestal should have a 4 bolt flange (6 inch by 6 inch, 1/2 inch thickness) welded to the base. The pedestal will be expansion bolted to the concrete pavement adjacent to the barrier arm operator. A card reader with exposed conduit will be installed on this pedestal. Paint the pedestal yellow to match the Barrier Arm

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that the pavement is in suitable condition to begin installation according to manufacturer's written instructions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install per Manufacturers written instructions.

END OF SECTION

SECTION 333111 - SITE SANITARY UTILITY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Cleanouts.

1.2 SUBMITTALS

A. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage 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 service according to requirements indicated:

1. Notify Architect and no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect's Owner's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, T-2 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.2 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty .
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.3 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R , and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Heavy-Duty, top-loading classification cleanouts in all areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

D. Where cleanouts are at changes in direction, install a wye-type bend for direction change and connect cleanout to open side of wye bend so cleanouts open in direction of flow in sewer pipe.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 . Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Fill piping to be abandoned with Controlled Low-Strength Material as specified in section 312000.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.8 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

   a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
   b. Close openings in system and fill with water.
   c. Purge air and refill with water.
   d. Disconnect water supply.
   e. Test and inspect joints for leaks.

6. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.

   a. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

7. Manholes: Perform hydraulic test according to ASTM C 969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

E. Field Installation Survey: Contractor will provide survey of piping as field-installed, including depth of pipe, flowline of structures, top of rims of structures, and horizontal location of all components of sanitary sewer systems, to Architect at conclusion of the project.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Manholes.
3. Stormwater inlets.

1.2 SUBMITTALS

A. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. Stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle manholes according to manufacturer's written rigging instructions.

C. Handle stormwater inlets according to manufacturer's written rigging instructions.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage 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 service according to requirements indicated:

1. Notify Architect and no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10 : AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 : AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS

A. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, T-2 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets
2. Class III, Wall B.

2.4 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Base Section: 8-inch minimum thickness for floor slab and 6-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
4. Riser Sections: 6-inch minimum thickness, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, 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 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
9. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.5 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R , and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
2. Benches: Concrete, sloped to drain into channel.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.6 STORMWATER INLETS

A. Area Inlets: Made of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

B. Frames and Grates: Heavy duty, according to utility standards.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

E. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install PE corrugated sewer piping according to ASTM D 2321.
3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
4. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
3. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

B. Where cleanouts are at changes in direction, install a wye-type bend for direction change and connect cleanout to open side of wye bend so cleanouts open in direction of flow in sewer pipe.

3.4 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.5 STORMWATER INLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.7 CONNECTIONS

A. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 . Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

    a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

    a. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

b. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.8 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:

1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section "Earth Moving."

3.9 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

E. Field Installation Survey: Contractor will provide survey of piping and structures as field-installed, including depth of pipe, flowline of structures, top of rims and grates of structures, and horizontal location of all components of storm drain systems, to Architect at conclusion of the project.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION 334100

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